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VOL. CXLI.—No. 3658] LONDON: FRIDAY EVENING, FEBRUARY 5, 1926 [PRICE ONE SHILLING BY INLAND POST 1s. 3d.

PUBLIC NOTICES

The Director - General, India Store Department, Branch No. 15, Belvedere-road, Lambeth, S.E. 1, invites TENDERS for :—
MATERIALS for CABOOSE BRAKE VANS, excluding Underframes.
Tenders due on the 23rd February, 1926.
Tender forms obtainable from above. 1529

Assistant Engineers (2) REQUIRED by the GOVERNMENT of UGANDA for the PUBLIC WORKS DEPARTMENT, for a tour of 20 to 30 months' service, with possible extension. Salary £400, rising to £800 a year, plus a temporary local allowance at present authorised up to the 31st of March. Outfit allowance of £30 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, aged 25 to 30 years, must be A.M.I.C.E. or hold equivalent professional qualifications, and preferably have received training and experience in a Municipal Engineer's Office. Must possess a sound knowledge of Building and Road Construction.—Apply at once by letter, stating age, qualifications and particulars of experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/14,306. 1547

Civil Engineers (3) Re- QUIRED by the GOVERNMENT of SIERRA LEONE for the PUBLIC WORKS DEPARTMENT, for two tours of from 12 to 18 months' service, with possible extension. Salary £600, rising to £720 a year by annual increments of £30. Outfit allowance of £60 on first appointment. Free passages and quarters and liberal leave on full salary. Candidates, aged 30 to 35, must have served articles with a corporate member of the Institution of Civil Engineers, and have passed the examination qualifying for A.M.I.C.E. or hold equivalent professional qualifications. Must be good Draughtsmen, capable of Designing and Carrying Out Buildings, Bridges and other Engineering Structures and of Taking Out Quantities and Preparing Detailed Plans and Estimates. Must be competent to Execute Surveys and to Lay Out and Construct Roads and have had experience as Civil Engineers on the Construction of Roads, Buildings and other Public Works.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, London, S.W. 1, quoting M/14,274. 1546

Engineering Draughts- MAN REQUIRED by the GOVERNMENT of UGANDA for the PUBLIC WORKS DEPARTMENT for a tour of 20 to 30 months' service with possible extension. Salary £400, rising to £500 a year plus a temporary local allowance at present authorised up to the 31st of March. Free quarters and passages and liberal leave on full salary. Outfit allowance of £30 on first appointment. Candidates, aged 30 to 35, must be good Draughtsmen and have had a varied experience in the Drawing-office of some important Civil Engineering Firm. Must be able to undertake the Plotting of Plans and Sections of Surveys, the Calculation of Quantities of Earthwork and Structures such as are required in Civil Engineering Schemes. Must have a practical knowledge of Surveying and Levelling.—Apply at once by letter, stating age, qualifications and experience, to the CROWN AGENTS FOR THE COLONIES, 4, Millbank, Westminster, London, S.W. 1, quoting M/14,291. 1548

Quantity Surveyor Re- QUIRED for the PUBLIC WORKS DEPARTMENT of SIERRA LEONE, for two tours of 12 to 18 months' service, with possible extension. Salary £540, rising to £720 a year by annual increments of £30. Outfit allowance of £60 on first appointment. Free quarters and passages and liberal leave on full salary. Candidates, aged 28 to 35, must be fully qualified Quantity Surveyors, experienced in the practice of "Taking Off," "Billing," and "Estimating" and "Measuring Up" for all classes of Building Work. Should have been engaged in a first-class Quantity Surveyor's Office and preference will be given to candidate holding the Fellowship of the Surveyors' Institution in the Quantities Division.—Apply at once by letter, stating age, qualifications and experience to the CROWN AGENTS FOR THE COLONIES 4, Millbank, Westminster, S.W. 1, quoting M/14,277. 1545

INDIAN RAILWAY SERVICE OF ENGINEERS.

The Secretary of State for India in Council will in 1926 APPOINT not less than 3 ASSISTANT EXECUTIVE ENGINEERS for this Service if so many suitable candidates present themselves.

Every candidate must be a British subject or a ruler or subject of any State in India in respect of whom the Governor-General of India in Council has made a declaration that he is to be considered eligible.

Candidates must be not less than 21 years and not more than 25 years of age on 1st August, 1926.

They must either (1) have obtained one of certain recognised university degrees or other distinctions in engineering, or (2) have passed Sections A and B of the Associate Membership Examination of the Institution of Civil Engineers or been exempted by the Institution from such examination, or (3) produce the required evidence that they are otherwise eligible under the regulations. They must in addition have had at least one full year's practical experience of civil engineering under a qualified civil engineer at the time when they appear before the Selection Committee.

Applications from candidates must reach the India Office not later than 10th April. Printed forms, together with information regarding the conditions of appointment, may now be obtained from the SECRETARY, Public Works Department, India Office, Whitehall, London, S.W. 1. 1492

County Borough of Southend- ON-SEA.

The Corporation of Southend-on-Sea invite OFFERS for the undermentioned SCRAP METAL now lying at Southchurch-road Depot :—
Approx. 90 Tons Old 7in. English Tram Rail and 6½in. Belgian and American, in lengths of 30-40ft.
Approx. 50 Tons Old Tram Rail, various makes, in short lengths.
Approx. 10 Tons General Scrap Tramway Metal.

Dealers desiring to submit Offers should make an inspection of the material and obtain particulars from Mr. Robert H. Dyer, Borough Engineer.

Offers, endorsed "Scrap Tramway Metal," should reach the office of the Borough Engineer not later than 9 a.m., Friday, 12th February, 1926.

H. J. WOREWOOD,
Town Clerk.

Municipal Buildings, Southend-on-Sea,
February, 1926. 1504

The Engineer

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PUBLIC NOTICES

Northampton Polytechnic INSTITUTE,
ST. JOHN-STREET, E.C. 1.
A SPECIAL COURSE OF SIX LECTURES on
"The METALLOGRAPHY AND HEAT TREATMENT OF IRON AND STEEL" will be given on
THURSDAY EVENINGS, at 7 p.m., by Mr. R. GENDERS, M.B.E., M.Met., F.I.C., Commencing on 11th February, 1926, as follows :
February 11th, Wrought Iron and Shear Steel.
February 18th, Properties and Heat Treatment of Carbon Steels.
February 25th, Special Purpose Steel.
March 4th, Tool Steels.
March 11th, Defects in Steels.
March 18th, Cast and Malleable Cast Iron.
These lectures are open to the public without fee.
S. C. LAWS,
1501 Principal.

The University of Birmingham.
FACULTY OF SCIENCE.
PROFESSORSHIP OF METALLURGY.
The Council of the University invites APPLICATIONS for the CHAIR of METALLURGY.
The stipend will be £1000 a year.
The Professor will be allowed to take higher consultative work, to keep in touch with metallurgical practice, provided that it does not interfere with his University duties.
Twenty-four copies of applications, together with copies of not less than three testimonials, references, or other credentials, if desired, should be received by the Secretary not later than March 1st, 1926.
The successful candidate will be required to take up his duties on October 1st, 1926.
Further particulars may be obtained from
O. G. BURTON,
1401 Secretary.

Bengal-Nagpur Railway Com- PANY, LIMITED.
The Directors are prepared to receive TENDERS for :—
628 TONS STEEL FLAT-BOTTOM RAILS, 40 lb. per yard.
Specification and form of Tender can be obtained at the Company's Offices, 132, Gresham House, Old Broad-street, London, E.C. 2, on or after 2nd February, 1926.
A fee of 20s. will be charged for the specification, which is NOT returnable.
Tenders must be submitted not later than Noon on Friday, 12th February, 1926.
The Directors do not bind themselves to accept the lowest or any Tender, and reserve to themselves the right of reducing or dividing the order.
By Order of the Board,
R. C. VOLKERS,
1506 Secretary.

PUBLIC NOTICES

Administrative County of LONDON.
SCAVENGING, &c., OF THAMES EMBANKMENTS AND BRIDGES.
The London County Council invites TENDERS for the SCAVENGING, &c., of the THAMES EMBANKMENTS and BRIDGES for a period of twelve months, commencing 1st April, 1926.
Persons desiring to submit Tenders may obtain the form of Tender, &c., on application to the Chief Engineer at the Old County Hall, Spring-gardens, S.W. 1, upon payment of the sum of £3 by cheque or draft to the order of the London County Council. This amount will be returnable only if a bona fide Tender is sent and not subsequently withdrawn. Full particulars of the work may be obtained on personal application, and the contract documents may be inspected before payment of the fee.
No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E., after 4 p.m. on Monday, 22nd February, 1926, will be considered.
The contractor will be bound to observe the provisions of a fair wages clause, the terms of which are set out fully in the instructions for Tender and form of contract and in the "London County Council Gazette."
The Council does not bind itself to accept the lowest or any Tender.
MONTAGU H. COX,
1510 Clerk of the London County Council.

Administrative County of LONDON.
REMOVAL OF SEWER DEPOSIT.
The London County Council invites TENDERS for the REMOVAL and DISPOSAL of SEWER DEPOSIT and other Materials in connection with the Main Drainage, &c., Services for four districts—two north of the Thames and two south of the Thames, east and west respectively, for a contract for twelve months commencing 1st April, 1926.
Persons desiring to submit Tenders may, on and after Monday, 8th February, 1926, obtain the schedule of prices, form of Tender, &c., on application to the Chief Engineer at the Old County Hall, Spring-gardens, S.W. 1, upon payment of the sum of £1 by cheque or draft to the order of the London County Council. This amount will be returnable only if the tenderer shall have sent in a bona fide Tender, and shall not have withdrawn the same. Full particulars of the work may be obtained upon personal application, and the contract documents may be inspected before payment of the fee.
No Tender received by the Clerk of the Council at the County Hall, Westminster Bridge, S.E. 1, after 4 p.m. on Monday, 1st March, 1926, will be considered.
The contractor will be bound to observe the provisions of a fair wages clause, the terms of which are set out fully in the instructions for Tender and form of contract, and in the "London County Council Gazette."
The Council does not bind itself to accept the lowest or any Tender.
MONTAGU H. COX,
1557 Clerk of the London County Council.

PUBLIC NOTICES

Scarborough Corporation.
NEW IRTON WATER SCHEME.—CONTRACT NO. 7.
SERVICE RESERVOIR.
The Corporation invite TENDERS for the CONSTRUCTION of a CONCRETE SERVICE RESERVOIR of 5,000,000 gallons capacity on Spring Hill, Scarborough.
The floor and walls will be of mass concrete and the roof reinforced with B.R.C. fabric. The work will also include heavy embanking and some pipe laying and accessories.
Copies of the conditions, specification, schedule of prices and form of Tender prepared by the Engineer, Dr. H. Lapworth, M. Inst. C.E., 25, Victoria-street, Westminster, may be obtained on application to the undersigned on or after Monday, January 25th. The application must be accompanied by a sum of £5, which will be refunded on return of the documents within seven days or after the receipt of a bona fide Tender and the documents required.
Facilities for examining the drawings, for inspecting the site and general information can be obtained on application to Mr. Herbert Richardson, the Water and Streets Engineer to the Corporation, Town Hall, Scarborough.
Tenders are to be sent in on the form supplied, and with the annexed documents must be enclosed in a sealed cover, endorsed "New Irton Water Scheme : Tender for Contract No. 7," addressed to and reaching the undersigned not later than 10 a.m. on Monday, the 1st March, 1926.
The Corporation do not bind themselves to accept the lowest or any Tender.
SYDNEY JONES,
Town Clerk.
Town Hall, Scarborough,
January 22nd, 1926. 1433

Staffordshire Potteries Water BOARD.
HANCHURCH RESERVOIR EXTENSION.
The Board is prepared to receive TENDERS for th CONSTRUCTION of a Six Million Gallon RESERVOIR, built of Mass Concrete partly reinforced.
Plans may be seen and specification and bill of quantities obtained on or after the 1st February, 1926, at my office on payment of £5, which will be returned on receipt of bona fide Tender.
Tenders, accompanied by priced schedule, endorsed "Reservoir" and addressed to "Chairman, Staffordshire Potteries Water Board, Albion-street, Hanley, Stoke-on-Trent," must be received not later than Noon of Monday, 15th February, 1926.
The Board do not bind themselves to accept the lowest or any Tender.
E. C. FRAIN, M. Inst. C.E.,
Engineer and General Manager.
Albion-street, Hanley, Stoke-on-Trent.
January, 1926. 1463

The South Indian Railway Com- PANY, LIMITED.
The Directors are prepared to receive TENDERS for the SUPPLY of :—
1. PAINTS and DRYSALTERIES.
2. SCREWS, BOLTS and NUTS, &c.
3. GALVANISED CORRUGATED SHEETS.
4. SOLID-DRAWN STEEL BOILER TUBES.
5. LOCOMOTIVE BOILERS.
6. INDIA RUBBER GOODS.
7. METALS (Pig Lead and Antimony).
8. STEEL DRAW-BAR SHACKLES, &c.

Specifications and forms of Tender will be available at the Company's Offices, 91, Petty France, Westminster, S.W. 1.
Tenders, addressed to the Chairman and Directors of the South Indian Railway Company, Limited, marked "Tender for Paints and Drysalteries," or as the case may be, must be left with the undersigned not later than Twelve Noon on Friday, the 19th February, 1926.
The Directors do not bind themselves to accept the lowest or any Tender.
A charge, which will not be returned, will be made of 10s. for each copy of Specifications Nos. 1, 2, 3, 4, and 5; of 5s. for each copy of Specifications Nos. 6 and 7; and of 2s. 6d. for each copy of Specification No. 8.
Copies of the drawings may be obtained at the offices of the Company's Consulting Engineers, Messrs. Robert White and Partners, 3, Victoria-street, Westminster, S.W. 1.
W. B. REYNOLDS,
For Managing Director.
91, Petty France, S.W. 1,
3rd February, 1926. 1549

Sudan Government Railways REQUIRE the SERVICES of DISTRICT LOCOMOTIVE SUPERINTENDENT. Age 28 to 32, preferably single. Candidates should have been trained on a British railway or in a locomotive builder's works, and should have good knowledge of the working of a locomotive department. A.M.I.C.E. degree or equivalent desirable. Commencing salary £480 to £540 per annum, according to age and qualifications (£1 equals £1 0s. 6d.). Progressive and pensionable post if satisfactory. Strict medical examination. Free first-class passage. Liberal leave and assisted passages.—Apply by letter to ADVISORY ENGINEER, Sudan Government London Office, Wellington House, Buckingham-gate, S.W. 1, marking envelope "Dist. Loco. Supt." 1516

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PUBLIC NOTICES

WESTERN AUSTRALIA.

Applications are Invited by the Agent-General for Western Australia for the POSITION of PRINCIPAL ASSISTANT ENGINEER, Metropolitan Water Supply and Sewerage, in the Public Works Department of the Western Australian Government.

Commencing salary £600, rising to £672. Transport allowance £200 for married man, £100 for single man. Should the successful applicant voluntarily relinquish his position before the expiration of 2 years from the date of appointment, he will be called upon to refund the amount of the above allowance.

Applicant should state age and whether married or single.

Applications should be endorsed "Engineer," and must reach the AGENT-GENERAL for WESTERN AUSTRALIA, Savoy House, 115, Strand, London, W.C. 2, on or before the 15th March, 1926. 1500

SITUATIONS OPEN

WANTED for London, GENERAL ENGINEER, with knowledge of Builders' Plant. Good opening for young energetic man. State age, experience, and salary.—Address, P1494, The Engineer Office. P1494 A

WANTED for Near London, ENGINEERS' COST CLERK, accustomed to piecework pay rolls, allocation of job charges, material charges, maintenance costs, &c.—Address, stating experience and salary required, P1533, The Engineer Office. P1533 A

A PROGRESSIVE FIRM REQUIRES the SERVICES of an ENGINEER, experienced in the design, construction and testing of Two-stroke Heavy Fuel Oil Engines of most modern type. Excellent prospects for a man of energy, ability and initiative.—Write, stating experience and full particulars, to W.L.P., 6, Lincoln-road, Richmond, Surrey. 1515 A

BRITISH AIR CONDITIONERS, Ltd., Have VACANCY for TWO or THREE competent ASSISTANT ENGINEERS to undertake design and lay-out details of Plenum, Humidifying and Ventilating Installations. State age, experience, and salary, in strictest confidence.—Address, 1517, The Engineer Office. P 1517 A

CONTRACTOR'S ENGINEER or ASST., Supervise Factory Buildings and Office Work. London; £250 p.a. Good scope to keen engineer.—Address fully, P1540, The Engineer Office. P1540 A

REQUIRED for Metals Dept. of Old-established firm in India, capable SALESMAN, with an intimate knowledge of the Heavy Iron and Steel Trade; age about 35; must be single.—Reply fully, stating age, experience and present salary, to "Z.B. 188," care of Deacon's Advertising Offices, Fenchurch-avenue, London, E.C. 3. 1535 A

WORKS MANAGER or SUPERINTENDENT for Electrical Factory manufacturing Switchgear and Radio Components. Keen, capable man of proved ability, tactful, disciplinarian, qualified in modern manfg. methods of tooling, machining, assembly and finishing.—Write full details experience, salary, Box 1767, Selfe, Fleet-street, E.C. 4. 1522 A

WANTED, Capable DRAUGHTSMAN, with Locomotive experience preferred, for Steam-driven Rail Cars.—Address, stating experience and salary required, P1505, The Engineer Office. P1505 A

WANTED, JUNIOR DRAUGHTSMAN for Engineering Works in Bombay; some knowledge of Structural Work an advantage. Salary commencing Rs. 500 per month, 5-year agreement.—Write, giving full particulars of experience, age and whether married or single, to "Z.T. 223," c.o. Deacon's Advertising Offices, Fenchurch-avenue, London, E.C. 3. 1535 A

A COMPETENT MECHANICAL DRAUGHTSMAN REQUIRED, S.W. London, age 25 to 30, with good all-round experience designing new classes of Machinery. Excellent prospects and salary to the right man.—Address, P1515, The Engineer Office. P1515 A

BRITISH AIR CONDITIONERS, Ltd., Artificial Silk Engineers, REQUIRE the SERVICES of THREE or FOUR DRAUGHTSMEN who have had extensive experience in Fan and Sheet Iron Duct Work. Only men with the highest qualifications considered. Excellent opportunity for real live men.—Communicate personally either with Mr. BROADHURST CRAIG, 1, Fitzroy street, London, W. 1, or Mr. G. C. MILLS, at 22, Cooper street, Manchester. 1508 A

CHIEF ENGINEER'S ASSISTANT WANTED, accustomed to Land Engines, Boiler, and Turbine Work. Full experience and age must be stated.—Address, 1498, The Engineer Office. 1498 A

DRAUGHTSMEN.—BEFORE NEGOTIATING with Government Departments in connection with any post, PLEASE COMMUNICATE with the GENERAL SECRETARY, Association of Engineering and Ship Building Draughtsmen, 98, St. George's-square, London, S.W. 1. 1160 A

DRAUGHTSMAN, Experienced in Steel Construction Work, capable of getting out quantities and details.—Address, stating age, experience, and salary required, 1510, The Engineer Office. 1510 A

DRAUGHTSMAN, JUNIOR, Also IMPROVER, for Constructional Engineers, London; local applicants; prev. exp. essential. State wages and exp.—Address, P1539, The Engineer Office. P1539 A

DRAUGHTSMEN REQUIRED—Senior and Junior—for Chassis and Body Design. Used to Commercial Vehicles or Large Passenger Type. State exact particulars of experience and where gained, age, and salary required.—Address, 1407, The Engineer Office. 1407 A

DRAUGHTSMEN.—WANTED IMMEDIATELY, SEVERAL First-class DRAUGHTSMEN experienced in High-speed Petrol and Oil Engine Work. Applications from thoroughly qualified men only considered. Apply, giving detailed particulars of experience, age, and salary desired.—Address, "DRAUGHTSMEN," Wm. Porteous and Co., Advertising Agents, Glasgow. P1467 A

INDIA.—REQUIRED by British Firm of Engineers, DRAUGHTSMAN, accustomed to Roof, Bridge, and Structural Steelwork, able to Work Out Stresses and Prepare Designs, Estimates and Detail Drawings; must be a fast worker, age 25 to 37.—Apply, stating age and particulars of experience, to "Z.L. 217," c.o. Deacon's Advertising Offices, Fenchurch-avenue, London, E.C. 3. 1534 A

MESSRS. NEWTON, CHAMBERS and CO., Ltd., Thorncliffe Ironworks, near Sheffield, REQUIRE the additional SERVICES to their permanent staff of a responsible DRAUGHTSMAN with experience in Gas, Chemical and General Constructional Work.

Applicants are requested to state their qualifications, age, experience, salary required, and date duties could be begun after appointment. 1446 A

TRACER—Expert Male—REQUIRED for Chassis and Body Work. State particulars of experience, age, and salary required.—Address, 1551, The Engineer Office. 1551 A

ASSISTANT to BOILERSHOP FOREMAN REQUIRED by Firm making Dry Back, Loco. Type and Portable Engine Boilers. Should be preferably man with all-round boilershop experience, including Acetylene and Electric Welding, good control of men and sound organiser. Good prospects for right man. Applicants should state age and when disengaged, previous experience, and salary required.—Address, 1494, The Engineer Office. 1494 A

FOREMAN WANTED in the Midlands for Machine and Fitting Shop; one used to Conveyors and Elevators, with a knowledge of Plating Shop Work preferred; must be well up in modern Machine Shop Methods. First-class knowledge of Fixing Piecework Prices, tactful and resourceful. State age and wages required, enclosing copies of references.—Address, 1544, The Engineer Office. 1544 A

SITUATIONS OPEN (continued)

YOUNG MECHANIC, with Tool-making Experience, to Take Charge of Production of Small Precision Work.—TAYLOR, HOBSON, Leicester. P1516 A

SITUATIONS WANTED

ADVERTISER (27), Having Just Resigned Post in editorial control of well-known weekly journal of the metal industries, will be FREE to TAKE UP a NEW APPOINTMENT at the end of February. Twelve years' extensive experience in various branches of engineering and metallurgical work, all departments research to selling. Sound technical, commercial, and economic qualifications. Almost fluent French.—Write, W. H. SAWYER, 18, Tonbridge House, Tonbridge-street, W.C. 1. P1503 B

A.M.I. MECH. EXAM., LECTURER, Extensive MAINTENANCE EXPERIENCE, Steam (Coal and Oil Fuel) and Diesel, DESIRES SITUATION. Excellent references.—Address, P1507, The Engineer Office. P1507 B

CIVIL ENGINEER, B.Sc., A.M.I.C.E., WANTS EMPLOYMENT. Railway location and construction, also irrigation. Working knowledge of Spanish.—Address, P1500, The Engineer Office. P1500 B

ENGINEER (Civil), Residing London District, is OPEN for APPOINTMENT. Engaged for over 30 years (9 in U.S.A.) as assistant on surveys and designs, resident on construction, and contractor's agent. Impounding and service reservoirs, large-size mains, pumping stations and other structural works, including timber and concrete piling, sewerage, including tunnel sewers, outfall treatment by irrigation and bacteria beds; asphalt streets, underground cable ducts, &c.—Address, P1475, The Engineer Office. P1475 B

ENGINEER, M.I.A.E., Designer Successful Trolley 'bus and electric vehicles, DESIRES similar POSITION sole charge design and testing). Good general engineering career, mechanical and electrical training. Originality of outlook.—Address, P1529, The Engineer Office. P1529 B

ENGINEER (28), Exper. Mech., Marine and I.C., DESIRES POST offering advancement, home or abroad. Wife competent shorthand typist and bookkeeper, exper. eng. trade.—MILNE, Godwin Garage, Margate. P1534 B

ENGINEER (30), with Six Years' Experience in the erection and running of sugar factories abroad, DESIRES responsible POSITION, at home or abroad. Capable and energetic.—Address, P1354, The Engineer Office. P1524 B

GENERAL MANAGER REQUIRES POST as Managing Director, General Manager or Works Director with progressive firm. Fully conversant with all modern methods, used to control of 1,000 hands, of proved ability in administration and reorganisation from design to intensive sales. Experience railways, locomotives, steam and petrol vehicles. Excellent testimonials.—Address, P1453, The Engineer Office. P1453 B

MECHANICAL ENGINEER, Age 38, SEEKS CHANGE; 19 years' practical and technical experience, fully capable of taking charge of large steam plant and machinery or installation; 12 years' practical experience in up-to-date plants in U.S.A. and Canada; guarantee high efficiency. Good references.—Address, P1520, The Engineer Office. P1520 B

MECHANICAL ENGINEER (42), Experience as manager of general engineering works, including pattern shop, smithy, foundry, machine shop and boiler shop, used to correspondence, estimating, travelling and all office routine, REQUIRES ENGAGEMENT.—Address, P1530, The Engineer Office. P1530 B

MECH. ENGINEER, G.I. Mech. E., Mech. Eng. Dipl., A.M.I.L.E., SEEKS POST with prospects, Midlands or South pref.; 5 years shops, 3 years eng. coll., 2½ years D.O.—Address, P1532, The Engineer Office. P1532 B

MECHANICAL ENGINEER, Jigs, Tools and Experimental work, knowledge of up-to-date shop practice, used to supervising, keen on costs, DESIRES POSITION of RESPONSIBILITY.—Address, P1522, The Engineer Office. P1522 B

M.I. MECH. E., Gentleman, Wide Engineering and commercial experience, recently managing director large engineering, transportation, timber and trading company, and loco supt., traffic manager, and assist. general manager important railways abroad, speaking Spanish, Portuguese, with first-class administrative ability, highest references, energetic, tactful, SEEKS ENGAGEMENT, home or abroad.—Address, P1482, The Engineer Office. P1482 B

MOTOR ENGINEER, Aged 36, Well Educated, served apprenticeship with leading British firm, skilled motor mechanic and chief instructor, later chief progress man, DESIRES POSITION, either at home or abroad, as Assistant Works Manager or Output Superintendent or as Representative attached to Branch Office or Works abroad. Would consider junior partnership in well-established garage.—Address, P1528, The Engineer Office. P1528 B

STEEL FOUNDRY MANAGER and METALLURGIST DESIROUS CHANGE; 7 years present position; excellent foundry record; experienced Tropenas and Siemens.—Address, 1422, The Engineer Office. 1422 B

STRUCTURAL STEEL WORK ERECTOR SEEKS BERTH, any capacity, home or abroad; experience plating and drawing; can take charge.—LANGDALE, 23, Acclom-street, West Hartlepool. P1508 B

WORKS and PLANT MAINTENANCE ENGINEER, A.M.I. Mech. E. (45), 18 years' experience with large mechanical and electrical engineering and manufacturing concerns, DESIRES APPOINTMENT.—Address, 1536, The Engineer Office. 1536 B

WORKS PRODUCTION ENGINEER (33) SEEKS ASSISTANT WORKS MANAGER or similar POSITION. London district preferred; used to control of staff, planning, tool design, shop experience, energetic.—Address, P1492, The Engineer Office. P1492 B

SENIOR DRAUGHTSMAN, Fully Experienced in mass production and efficiency methods, SEEKS CHANGE. Responsible position, offering good prospects for satisfactory service desired.—Address, P1523, The Engineer Office. P1523 B

EXPERIENCED TRACER, All Classes of Engineering works, OFFERS SERVICES, evenings and week-ends. Work expeditiously carried out at moderate charge.—Address, P1531, The Engineer Office. P1531 B

A LADY with Engineering Office Training SEEKS APPOINTMENT as CONFIDENTIAL ASSISTANT to Engineer. Experience in engineering and architectural drawing-office routine, correspondence, drawing, tracing, and artists' designing. London district.—Address, P1461, The Engineer Office. P1461 B

COST ACCOUNTANT, Trained Organiser, with varied experience in engineering, iron and steel, rolled metals, foundry, &c., DESIRES POST in Midlands entailing full charge and immediate responsibility to directors. Address, P1465, The Engineer Office. P1465 B

MACHINE SHOP FOREMAN SEEKS Similar POSITION; 16 years foreman, good organiser, up-to-date methods of mass production.—Address, P1527, The Engineer Office. P1527 B

PARTNERSHIPS

IF YOU ARE SEEKING
A PARTNER or PARTNERSHIP
or wish to buy or sell a
BUSINESS or WORKS
Write:
WHEATLEY KIRK, PRICE & CO.,
46, Watling Street,
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800 feet—1¼in.
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For continuation of For Sale Advertisements see page 4.

A Seven-Day Journal

The Status of Engineers in Belgium.

A BILL has just been introduced into the Belgian Parliament with the object of putting professional designations on the same legal footing as titles of nobility, and rendering everyone improperly using such designations liable to a fine of 1000f. According to a public explanation given by the author of the Bill, M. Jules Destrée, a former Minister of Arts and Sciences, the object is to prevent any person not possessing the corresponding University diploma from calling himself an engineer or an architect. The restriction of the titles of engineer and architect to those who have obtained University diplomas is justified by M. Destrée on the usual grounds of safeguarding the public, avoiding unfair competition of unqualified men, and encouraging young men to enter the professions by academic channels. As might be expected, the proposal has aroused violent opposition. The "Usurpers," as M. Destrée calls them, have formed a committee of protest and have published a statement of their objections to the Bill. They point out that the names of engineer and architect are more properly applicable to men who actually direct the carrying out of works than to those whose only qualification is to have "sat five years or more on University benches, and learnt many things without really understanding anything." The practical men with specialised knowledge, on whom modern industry so largely depends, have as much right to the title of engineer as the savants, and such men are just what the universities cannot produce. The committee claims, in short, that a practically trained man who has conducted his own studies should be under no disability because he has not been to a university.

Another Transatlantic Flight.

ON Sunday afternoon a Spanish airman, Major Franco, and three companions, completed the first stage in an adventurous attempt to fly from the Old to the New World and back again. The flight started on January 22nd, from Palos, a small seaport near Huelva. The Cape Verde Islands were reached without important incident, but at that point atmospheric conditions caused a delay. At 6.10 a.m. on January 30th the journey was resumed, and at 8 p.m. on the same day the machine alighted on the island of Fernando de Noronha, off the Brazilian coast, having covered a distance of about 1440 miles in just under fourteen hours. Having ridden out a storm, the machine left the island at 3 p.m. on the 31st, and reached the mainland at Pernambuco, at 4.45 p.m. The journey is to be continued to Buenos Aires, whence the machine will be flown across the Andes to Chili, and it is proposed to make the return flight by way of Panama, Mexico, the United States, Canada, Greenland, Iceland, Scotland and England. The total length of the route as planned is some 12,000 miles. The flight is in some respects an international one. The machine, a Dornier-Wal flying boat, is of German design, but was built in Italy by the Societa Idrovolanti Alta Italia. It is driven by two British-made Napier "Lion" engines of 450 horse-power each. In itself the flight so far accomplished is not, of course, unprecedented. Last year a very similar route was followed by two Portuguese airmen, while among several other flights the late Sir John Alcock's 1890-mile dash across the Atlantic in 16 h. 13 min. in June, 1919, deserves special mention as being still unsurpassed for daring and endurance.

American Views on Piston Temperatures.

IN view of the recent discussion before the Institution of Mechanical Engineers on Professor Gibson's paper dealing with piston temperatures in high-speed petrol engines, it may be of interest to refer to some remarks on aero-engine pistons made in a paper on modern American aircraft engine development, which Mr. Charles L. Lawrence presented yesterday—Thursday—before the Royal Aeronautical Society. Mr. Lawrence, a manufacturer of air-cooled engines in the United States, remarked that the design of pistons in his country seemed to be more or less stabilised, all makers using some form of ribbed piston, and all, with the exception of the Curtiss Company, using the type with the ribs perpendicular to the gudgeon pin axis. This design of piston follows the original Hispano type developed in 1914, but for a considerable period was displaced by the Liberty type of piston, a form practically without ribs and lending itself very readily to quantity production in metal moulds. The Liberty piston was at the time considered to be the best form for the dissipation of heat down the sides, and into the cylinder walls. It was, however, according to Mr. Lawrence, unduly heavy, and did not make use of the possibilities of heat dissipation by way of the oil thrown up into the inside of the piston. It is now believed in America that this method of cooling the piston is just as important as the transmission of heat down the sides. Experiments recently made on a piston with a single ring have led to the belief that the dissipation of heat through the piston rings, a course involving its passage through two oil films, has been greatly overrated. This belief is in marked contrast with the opinions of several who took part in the discussion before the "Mechanicals" a fortnight ago, and who were strongly of the view that the rings played a more important part in the dissipation of the heat than the piston skirt. Mr. Lawrence, we are interested to observe, states that the material most favoured in the United States for pistons is the Y alloy developed at the National Physical Laboratory, consisting of 92½ per cent. aluminium, 4 per cent. copper, 2 per cent. nickel, and 1½ per cent. manganese.

Indian Government Contracts.

IN the report of the India Store Department, London, for 1924–25, issued during the past week, it is stated categorically that in the allocation of the orders handled by the Department, British manufacturers receive no preference of any kind. Price, quality and delivery are solely considered, and every attempt, it is remarked, is made to encourage competition and enlarge the list of suppliers. In spite of this attitude, it would appear that British manufacturers still get the biggest share of the contracts for Indian stores. They are still able, the report states, to quote lower prices for satisfactory quality than their foreign competitors, and this fact explains why such a very high proportion of the purchases made fall to their lot. Excluding military and similar stores, the value of the goods purchased by the Department during the year from British manufacturers was £3,632,796, as compared with £526,883, the total value of the purchases in all foreign countries combined. The foreign percentage of the total purchases was therefore 12·6 and represents an increasing quantity, for in 1923–24 the percentage was 8·3 and in 1923–22 6·3. Of the purchases made abroad, those of an engineering character were conspicuous, and in this connection the report gives a few interesting figures showing the accepted foreign price and the lowest British tender. For three locomotive boilers the accepted price was £3520, while the lowest British tender was £4760. Seven locomotive boilers ordered abroad cost £10,770, as compared with £13,225 asked for them in this country. For five tank engines the Department paid the foreign manufacturer £20,750, as against £25,750 quoted by British makers. Four spans of bridgework were quoted at £2820 and £3597 by foreign and British firms respectively. For 41,000 boiler tubes the accepted foreign price was £10,400 as compared with the lowest British tender of £17,431.

A Direct-driven Diesel Locomotive.

DURING the past week successful preliminary trials were run with the new 1200 horse-power Diesel locomotive, with mechanical transmission gear, which is being constructed for the Russian State Railways by the Hohenzollern Locomotive Works, of Düsseldorf. The engine, which we recently saw under test, is of the 4–10–2 type, the power being developed by a six-cylinder M.A.N. submarine pattern motor designed for an output of 1200 brake horse-power at a speed of 450 revolutions per minute. A small airless injection engine is used to drive the ventilating fans for the water and oil coolers and also for providing by means of a generator the current required for the electric lighting and the controls. The power of the main unit is transmitted to the ten coupled driving wheels through a main magnetic clutch interposed between the engine fly-wheel and the reduction gear, and three other clutches are employed, one for each of the three operating speeds at which the locomotive is designed to work. So far the electrically operated magnetic clutches have given, we learn, every satisfaction, and we understand that an overall thermal efficiency greater than the 27·4 per cent. obtained with the Lomonossoff Diesel-electric locomotive has been registered.

Wages and Conditions in the Engineering Industry.

SINCE the forty-seven trade unions connected with the engineering industry made a joint application many months ago for an all-round advance in wages of 20s. a week numerous meetings with the employers have been held, and on more than one occasion the proceedings have appeared to be on the point of breaking down. The employers replied to the men's demand with a proposal to vary certain overtime and nightshift rates, to increase the bonus by 2s. per week and to extend the working hours from forty-seven to fifty per week. The men strongly objected to any extension of hours. The deadlock which ensued was only surmounted by the appointment of a joint deputation to discuss with the Government the possibility of bringing other nations more into line than they are at present with this country as regards working hours, a possibility opened up by the terms of the Peace Treaty and the Washington Convention on Labour. That deputation duly waited upon the Minister of Labour, but the outcome is not yet fully clear. Some difference of opinion seems to have arisen as to whether the Washington Convention should be recognised or ruled out in any international discussion that might be initiated. Correspondence which has passed between the British and foreign Governments shows that Belgium, Germany and Italy have agreed to attend any conference on the subject of working hours that may be arranged, but that no definite decision has so far been taken by France. The men's representatives are, it appears, still willing to co-operate with the employers in the pursuit of this international aspect of the questions in dispute, but on Thursday, Jan. 28th, they took the step of intimating that in other respects the negotiations were to be considered as finally broken off, and that they now considered themselves free to take what action they thought fit in support of their case. It is suggested as a possibility that the unions having failed to obtain a national advance, may now proceed on the basis of district applications and local bargaining.

New Orders for the Clyde.

CONSIDERABLE satisfaction will be felt in Scottish industrial circles generally following the various announcements of the last few days concerning upwards of thirteen naval and mercantile ships which are to be built on the Clyde. Yarrow and Co. (1922), Ltd., have been entrusted by the Admiralty with the construction of the four river gunboats provided for in the programme of naval construction which was published in July last. The new vessels will be high-speed shallow-draught boats, with the propellers working in tunnels on the Yarrow system. The propelling machinery will be of the turbine type and Yarrow boilers will be fitted. At the neighbouring Scotstoun yard of the Blythswood Shipbuilding Company, Ltd., orders have been received from Furness, Withy and Co., Ltd., for the construction of four twin-screw motor ships, each of about 10,000 tons deadweight carrying capacity. The machinery for these ships will be constructed at Greenock by J. G. Kincaid and Co., Ltd., and will comprise two eight-cylinder motors of the Kincaid-Harland-B. and W. type. Glasgow will also benefit by the order placed by M'Andrews and Co., Ltd., of London, with Harland and Wolff, Ltd., for four 2500-ton 12-knot motor ships for service between Liverpool and Spain.

Wireless Telephony between Ships and Shore.

A SYSTEM of wireless communication for which several rather important claims are made was recently put to the test of practical application. The inventor of the scheme, Mr. D. B. S. Shannon, of Sutton Coalfield, near Birmingham, first carried out some successful experiments between a private house in Guernsey and the Great Western Railway agent's office in that island, and subsequently between the former place and the Great Western Railway Company's steamship Reindeer *en route* from the Channel Islands to Weymouth. Speech transmitted through an ordinary telephone instrument connected to a special portable wireless transmitter on board the ship on the open sea could be clearly heard over a distance varying from 10 to 70 miles, whilst the ship's wireless operator was able to send two Morse messages from the wireless cabin without interfering with the wireless telephony transmission. The apparatus is portable and works without the use of an aerial or earth connection. Transmitting and receiving sets can be combined in the same case and duplex wireless telephony is possible. Ordinary land telephone lines can be used in conjunction with the apparatus, so that telephone conversation can be carried out between a telephone subscriber and a passenger on board a steamer. The selectivity of the apparatus is said to be very great and it is capable of working on very low wave lengths. The power required is quite small, that used for the experiments mentioned being from 5 to 7 watts.

The North Metropolitan Electric Supply Company's New Power Station.

THE proposal of the North Metropolitan Electric Supply Company to establish a power station at Brimsdown, near Enfield, has now taken definite shape, and contracts for the first section of the station, involving the erection of plant with a capacity of 40,000 kilowatts, have been placed. As far back as last September Captain Donaldson, the chief engineer, invited several of the leading engineering firms specialising in comprehensive power schemes to meet him for the purpose of discussing various proposals, and estimates for alternative schemes were finally prepared. The plant now in course of manufacture will conform in every way with the most modern power station practice. The Foundation Company, Ltd., is the main contractor and International Combustion, Ltd., the principal sub-contractor. The latter firm has been awarded the contract covering steam generation and transmission, and the Lopulco system of powdered fuel firing is to be installed. Babcock and Wilcox are building five boilers, each having a heating surface of 10,100 square feet, which will be equipped with Lopulco water screens and "Murray Usco" fin furnaces, which will increase the total heating surface to 11,000 square feet. The air preheating equipment is being supplied by James Howden and Co., Ltd., whilst the Power Speciality Company is supplying economisers and superheaters of the Foster type.

The Queen Mary Reservoir Conduit.

No. II.*

What was undoubtedly one of the most interesting parts of the whole of this 6ft. conduit was that portion of it which crosses under the Staines reservoirs aqueduct. The arrangement at the point of crossing is shown in Fig. 16. At the point of crossing, the top of the conduit only came about 2ft. 6in. below the bottom of the foundation of the aqueduct. It would therefore have been an extremely hazardous undertaking to endeavour to carry out tunnelling work with water in the aqueduct. Yet it was most undesirable that the flow of water down the aqueduct should be stopped for anything but the shortest

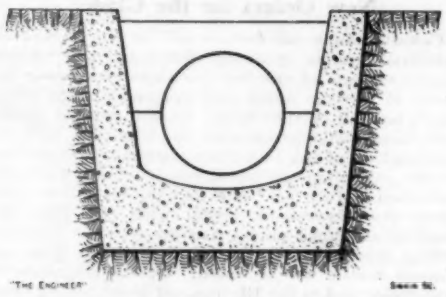


FIG. 13—SKETCH OF TUBE IN AQUEDUCT

possible time. It was therefore decided to convey the water across the portion of the aqueduct affected by the operations by means of a temporary pipe. It so happened that the Board was in possession of some old disused boiler furnace tubes, which were adapted for the service in a most ingenious manner. The cross tubes were cut out, and the holes thus left in the tubes were closed with steel plates. In order to make water-tight joints at the ends of the tubes, specially constructed concrete bulkheads were employed. These bulkheads were cast in two halves, an upper and a lower, the division between the two coming at the same level as the horizontal centre line of the tube. In each half of the bulkheads a semi-circular portion was cored out to the same radius as the tube, so that when the two halves were brought together they closely embraced the tube. Both halves had their outer edges shaped so as to conform to the internal contour of the aqueduct. The lower halves were placed in the bed of the aqueduct and the tube then lowered on to them so as to rest in the cored out portions. The top halves were then lowered into position and wedged there, after which all the joints—those between the bulkheads and the aqueduct sides and floor and those round the pipe, as well as the junctions between the top and bottom halves of the bulkhead—were carefully caulked with clay. The result was entirely satisfactory, no water at all entering the part of the aqueduct which it was desired to keep dry. The arrangements will be readily understood by the aid of the sketch, Fig. 13, and of Figs. 14 and 15. Of course, the carrying capacity of the tube was not as great as that of the aqueduct, but we understand that the desired flow of water could be obtained in the aqueduct with the loss of only 6in. in head.

A plan and sections of the aqueduct and conduit at the crossing place are given in Fig. 16, and the drawings show everything so clearly that no further description appears to be called for saving that the sides of the aqueduct for some little distance on either side of the point of intersection were strengthened with a buttress of concrete.

When this work was completed the tube was removed and the water again allowed to flow in the Staines reservoirs aqueduct. The tube was then used to carry the Staines aqueduct water past the point where connection was made between the discharge channel from the gauge basin at the Littleton end of the conduit and the aqueduct, as was shown in Fig. 9 *ante*. It was an excellent idea to employ for such a useful purpose these furnace tubes, which beforehand were practically scrap.

In the length of 3840 yards of this 6ft. conduit there are seven 36in. manholes of exactly similar type and connected to the conduit in exactly the same way as are the manholes in the 8ft. twin conduits, as already described and illustrated. The positions of these manholes will be seen in the drawings of the various portions of the conduit which are given on page 143.

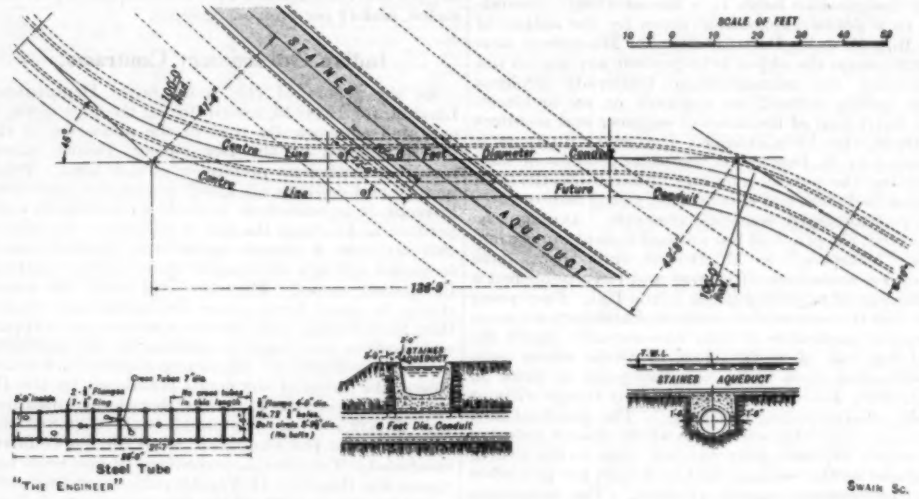


FIG. 16—THE QUEEN MARY RESERVOIR CONDUIT PASSING UNDER THE STAINES AQUEDUCT

For the whole of its length the 6ft. conduit runs parallel with and close alongside—first on one side and then on the other—of the Staines reservoirs aqueduct, and its extension, as a 48in. diameter cast iron pipe also follows the aqueduct, until the latter reaches the distribution reservoir seen on drawing No. 3 on page 143. After the branches from the two 8ft. conduits to the Staines reservoirs aqueduct there are no further branches until a distance of rather over 3350 yards is reached. At that point there is a 36in. branch from the right-hand side for a future connection to the filters at the Board's Hanworth pumping station, which originally belonged to the old East London Company. Some 200 yards further on there are two 48in. branches close to one another on the left-hand side of the conduit just before the latter passes under the Hanworth-road—see drawing No. 2, page 143. These branches are for connecting up at

FIG. 14—LOWERING UPPER HALF OF BULKHEAD ON TO TUBE

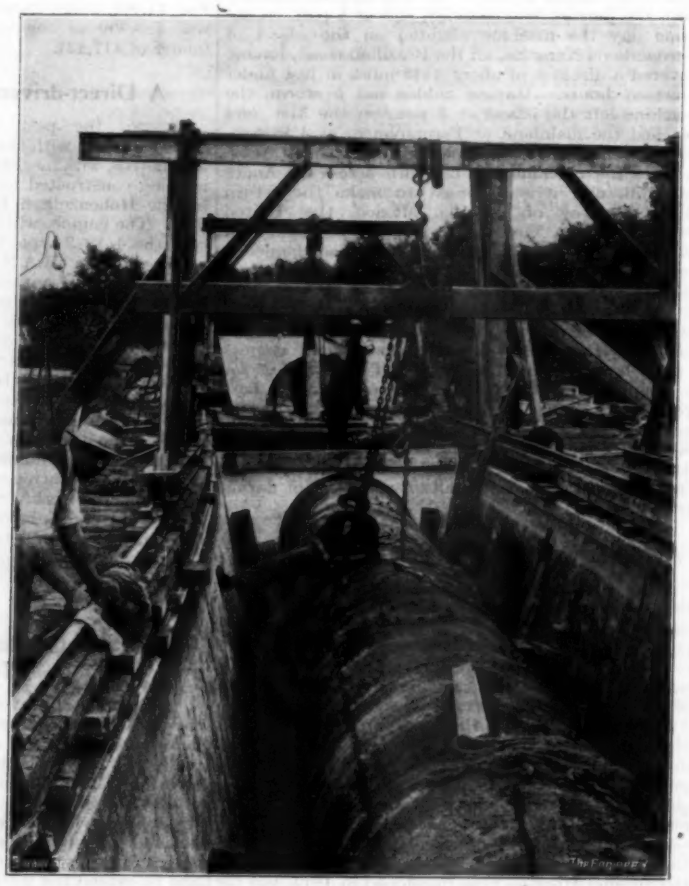


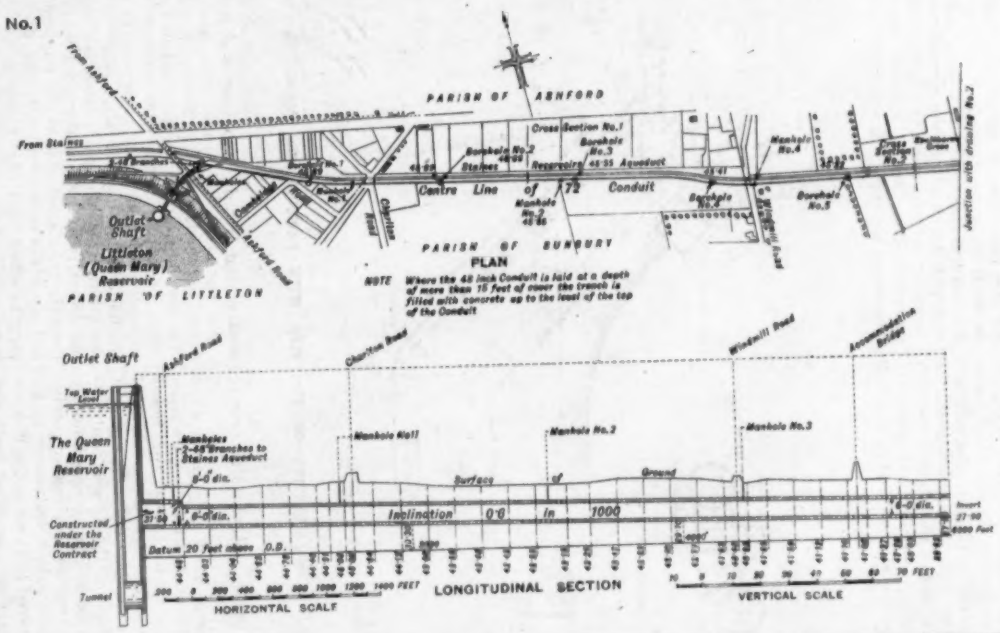
FIG. 15—UPPER HALF OF BULKHEAD LOWERED INTO POSITION.

* No. I. appeared January 29th.

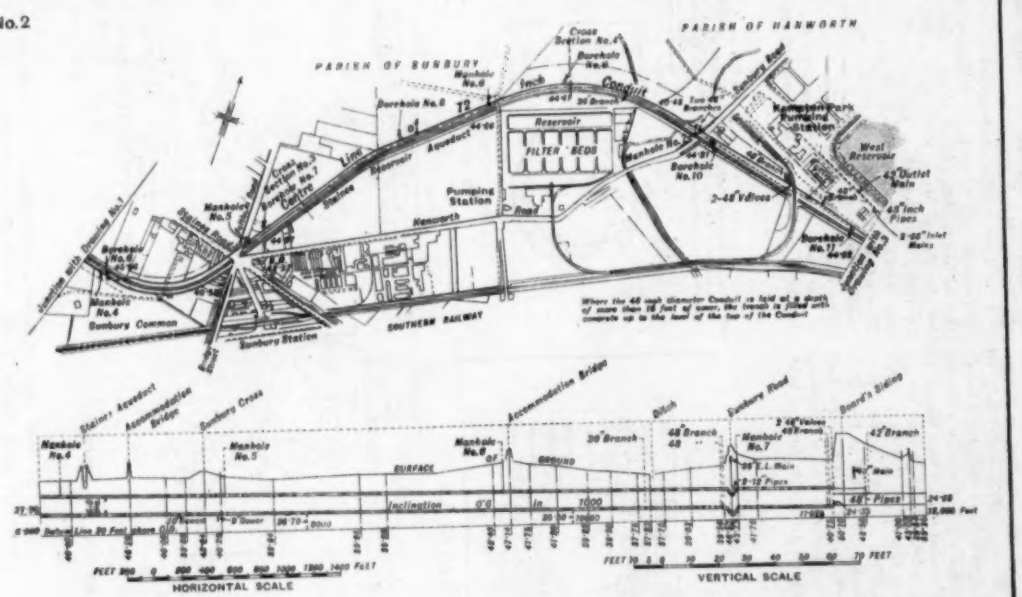
METROPOLITAN WATER BOARD—THE QUEEN MARY RESERVOIR CONDUIT

MR. HENRY E. STILGOE, M. INST. C.E., LONDON, ENGINEER

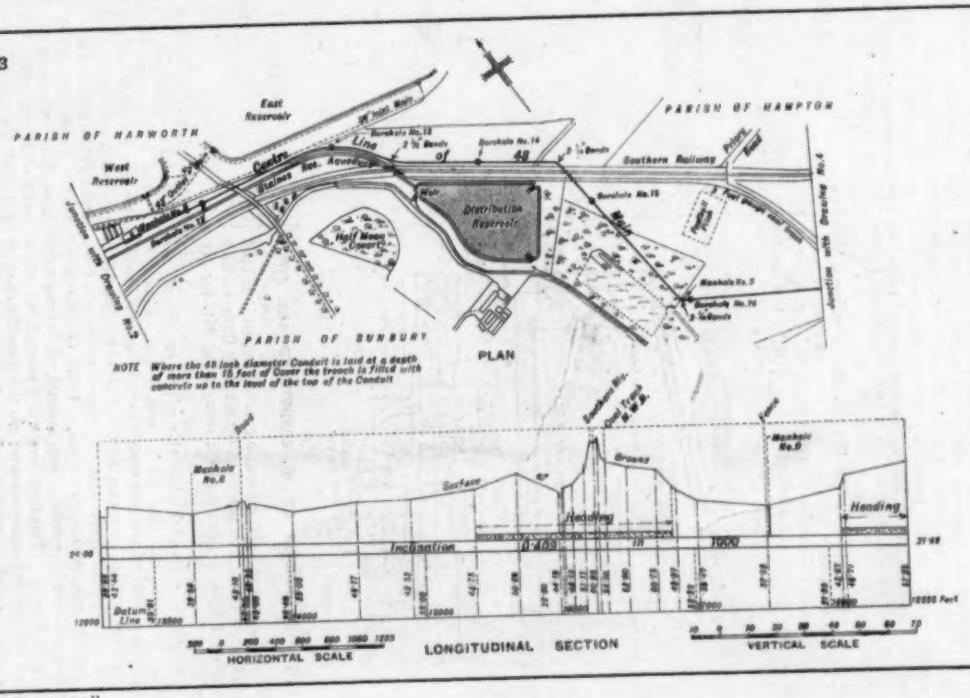
No.1


PARISH OF ASHFORD
PARISH OF SUNBURY
PARISH OF LITTLETON
Outlet Shaft
Littleton (Queen Mary) Reservoir
Centre Line of 72 Conduit
PLAN
NOTE Where the 48 inch Conduit is laid at a depth of more than 15 feet of cover the trench is filled with concrete up to the level of the top of the Conduit
Outlet Shaft
Ashford Road
Charlton Road
Windmill Road
Accommodation Bridge
The Queen Mary Reservoir
Constructed under the Reservoir Contract
Tunnel
Surface of Ground
Inclination 0·6 in 1000
Datum 20 Feet above O.D.
HORIZONTAL SCALE
LONGITUDINAL SECTION
VERTICAL SCALE

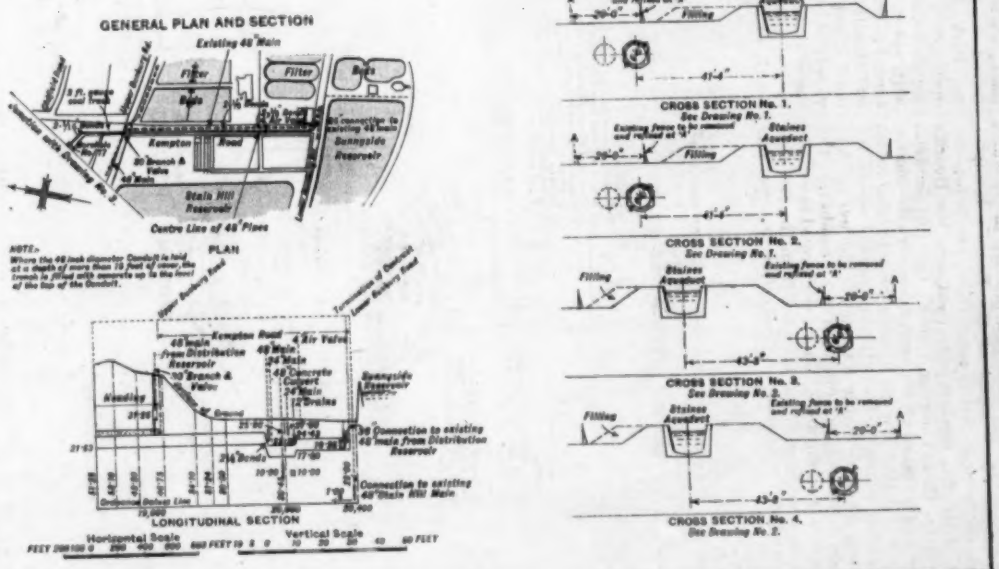
No.2



No.3


PARISH OF HANWORTH
PARISH OF HAMPTON
PARISH OF SUNBURY
East Reservoir
West Reservoir
Centre Line of 48
Distribution Reservoir
Half Moon Copse
Southern Railway
PLAN
NOTE Where the 48 inch diameter Conduit is laid at a depth of more than 15 feet of cover the trench is filled with concrete up to the level of the top of the Conduit
Heading
Inclination 0·6 in 1000
Datum Line
HORIZONTAL SCALE
LONGITUDINAL SECTION
VERTICAL SCALE

No.4



SWAIN Sc.

some future date to some new primary filters which it is proposed to instal at the Board's Kempton Park works near that point. Then, just before the end of the 6ft. conduit is reached near the Board's Kempton Park pumping station, two further 48in. branches are taken off for connection with the suction to the existing low-lift pumps and to the mains supplying water to the adjacent storage reservoirs. A 48in. diameter cast iron branch is also left for connecting the future duplicate 6ft. conduit. The branches from the 6ft. conduit were formed in exactly the same manner as the branches from the 8ft. conduit already referred to, and no further description is necessary. Each of the branches is furnished with a sluice valve of suitable size, see Fig. 17.

At the end of its course the 6ft. conduit is tapered down in the manner shown in Fig. 18 in order to make connection with the 48in. cast iron pipe which constitutes the conduit for the remainder of its length. The method of tapering and forming the junction is quite clear in this drawing and calls for no additional explanation. At the point of junction there is a 48in. sluice valve and then there comes a special pipe furnished with a flange to which is bolted a flanged 48in. elbow pipe bent to a radius of 5ft. 6in., to the other end of which is attached a 48in. sluice valve. The centre line of this valve, which is turned back so as to face in the direction of the Queen Mary Reservoir, is made to coincide with the what will be the centre line of the second 6ft. concrete conduit when it is laid. At present the valve is closed by a blank flange which is backed by a concrete block measuring 8ft. by 4ft. by 4ft.

Beyond the special pipe the pipes employed are 48in. British standard cast iron pipes, Class A. These are embedded in concrete where the depth below the surface exceeds 10ft. The total length is about 2880 lineal yards and the course traversed may be seen in the drawings on page 143. Of the total length about 877 yards are in tunnel, the remainder being in trench. The first length of tunnel, which is about 477 yards long, comes where the pipe line passes under the railway just beyond the Staines reservoirs aqueduct distribution reservoir. A second length, which is some 400 yards long, comes just before the pipe line reaches and passes under the Upper Sunbury-road—see Drawing No. 3, page 143. It was originally intended to tunnel under the Board's siding at Kempton Park, but this length was ultimately laid in open trench owing to the difficulty of driving a heading through the ballast, which was heavily charged with water. Just before the end of the last length of tunnel is reached there is a 36in. branch and valve, and that is the only branch taken off the 48in. main until it terminates with a 36in. connection to a previously existing 48in. main, as shown in Fig. 19. This connection is made in Lower Sunbury-road, quite close to its junction with Kempton-road—see Drawing No. 4, page 143—down which the pipe line is laid. Saving where in this—Kempton—road the pipe line had to be dropped in order to pass under two 48in., two 24in. and a 12in. pipes and some drains, the pipe line is laid at a uniform gradient of 0.409 in 1000. Its invert at the termination is 19.25 O.D., and since the level of the invert at the commencement of the conduit is 31.5 O.D., the total fall of conduit and pipe line, the combined length of which is some 6720 yards, is 12.25ft. As will have been gathered from the foregoing description, the whole length of conduit, unlike the Staines reservoir aqueduct, is always under pressure, and when the reservoir is full the pressure at the delivery end will be that due to a head of nearly 56ft. of water, or over 24 lb. per square inch.

Just before the termination of the pipe a 48in. Orivent meter is inserted in it, and the pressure pipes proceeding from this meter are led into a gauge house built at the side of the road. The pipe line is connected to the existing raw water mains feeding a series of filter beds along both sides of the Lower Sunbury-road at Hampton. The conduit has been admirably planned, for not only can supplies be given by gravity to the Staines reservoirs aqueduct, but water under pressure can also be delivered to three of the Board's works, at each of which there are filter beds and pumping stations, and the existing storage reservoirs at Kempton Park can be filled by gravitation from the Queen Mary Reservoir.

It will be readily understood that, in order to take full advantage of and to utilise in the best manner the additional supply of water which will be afforded by the Queen Mary Reservoir, it has been necessary to make considerable additions and alterations to the pre-existing network of supply and distribution mains. This work has been proceeding concurrently with the construction of the conduit. One of the disabilities from which the Metropolis suffered under the *régime* of the old water companies was that there were no means of communication between the systems of the different undertakings. It was impossible for one to go to the help of another in cases of emergency. That admittedly unsatisfactory condition of affairs had, following on a severe shortage in the area supplied by the East London Company, begun to be ameliorated before the formation of the Water Board by the provision of means of intercommunication between the areas of supply of the various companies. The urgent necessity, however, still remained to augment the supply to the several areas. Under the extensive scheme which is shortly to be put into full operation, large mains, requisite for a considerable increase of the supply of water throughout the whole area of the Board, have been and are being laid.

In our issue of June 19th last year, when describing the Queen Mary Reservoir itself, we stated that the late Sir James Restler had formulated no plans for employing the additional volume of water to be derived from the new source. That statement, we find, requires qualification, and we gladly give the following explanation, since the last thing that we desire is to say anything which might detract from the reputation of that able engineer. Sir James *had* given his consideration to the provisions necessary to effect that object, and his conclusions had been embodied in a report which he placed before a Committee of the Board in July, 1915, but the con-

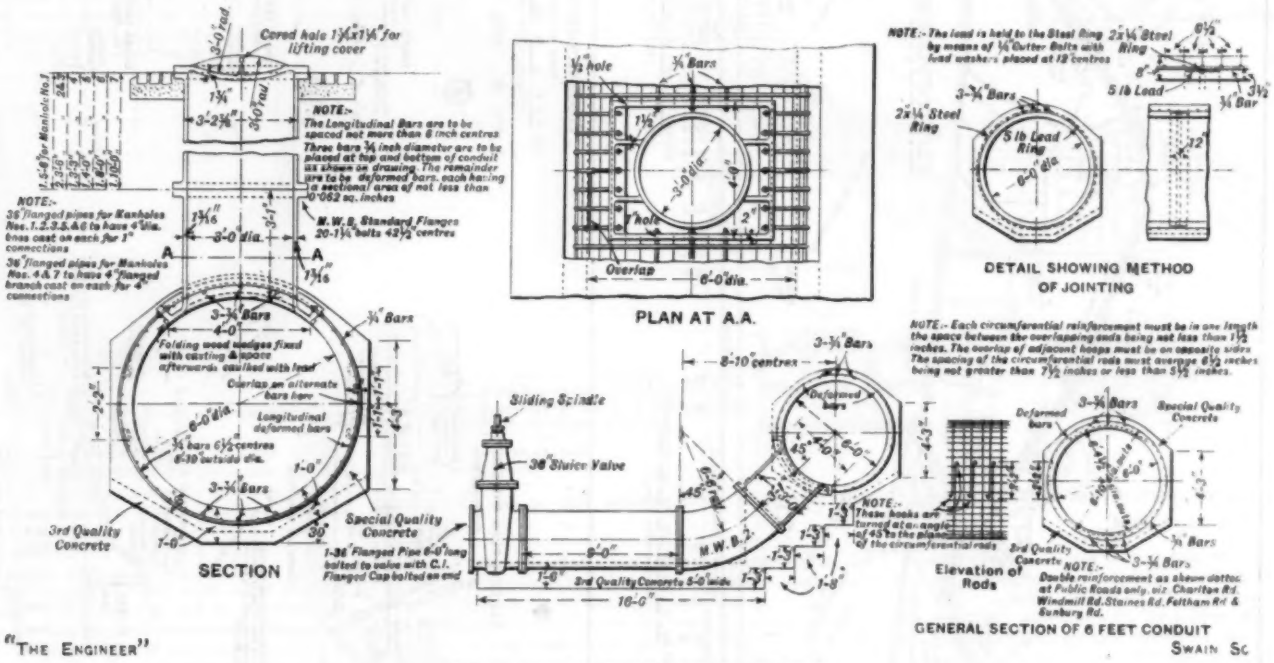

Cored hole 1¾"x1¼" for lifting cover
NOTE:- The Longitudinal Bars are to be spaced not more than 6 inch centres
Three bars ¾ inch diameter are to be placed at top and bottom of conduit as shown on drawing. The remainder are to be deformed bars, each having a sectional area of not less than 0·062 sq. inches
M.W.B. Standard Flanges 20-1¼" bolts 42½" centres
Folding wood wedges fixed with caulting & space afterwards caulked with lead
Overlap on alternate bars here
Longitudinal deformed bars
¾ bars 6½" centres 6'10" outside dia.
3rd Quality Concrete
Special Quality Concrete
1-36" Flanged Pipe 6'0" long bolted to valve with C.I. Flanged Cap bolted on end
SECTION
PLAN AT A.A.
Sliding Spindle
36" Sluice Valve
M.W.B.
3rd Quality Concrete 5'0" wide
16'0"
NOTE:- These hooks are turned at an angle of 45° to the plane of the circumferential rods
Elevation of Rods
NOTE:- Each circumferential reinforcement must be in one length the space between the overlapping ends being not less than 1½ inches. The overlap of adjacent hoops must be on opposite sides. The spacing of the circumferential rods must average 6½ inches being not greater than 7½ inches or less than 5½ inches.
NOTE:- Double reinforcement as shown dotted at Public Roads only, viz. Charlton Rd. Windmill Rd. Staines Rd. Feltham Rd & Sunbury Rd.
GENERAL SECTION OF 6 FEET CONDUIT
DETAIL SHOWING METHOD OF JOINTING
"THE ENGINEER"
SWAIN Sc

FIG. 17—VARIOUS DETAILS OF 6ft. CONDUIT

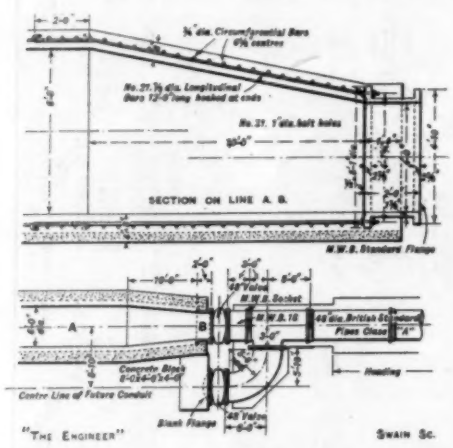


FIG. 18—CONNECTION OF 6ft. CONDUIT TO 48in. PIPE

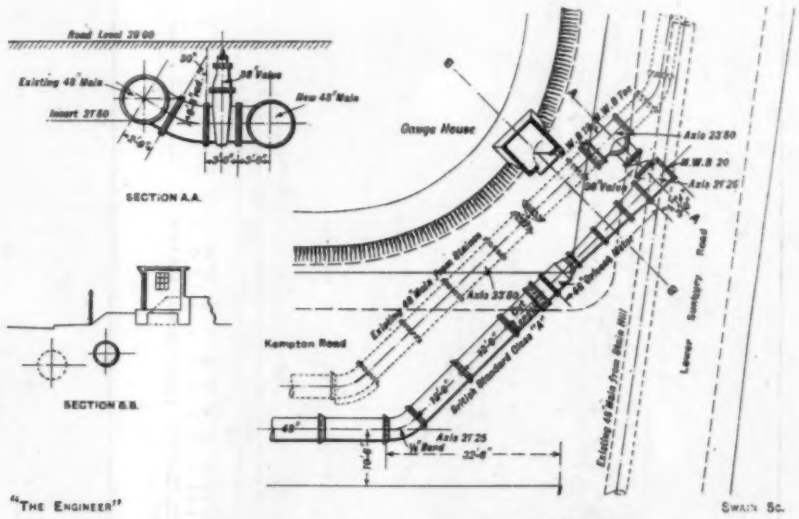


FIG. 19—FINAL JUNCTION OF 48in. PIPE WITH EXISTING 48in. MAIN

sideration of this report was postponed until a later date. This report was again brought forward to the same Committee in 1917, when its consideration was again postponed. It is hardly to be wondered at that Sir James Restler's proposals were not considered on these dates, as we were then in the midst of the world war, and constructional work on the reservoir itself had been stopped. So it happened that his scheme was never in any way considered by the Committee, nor was it brought before the Board itself.

As we pointed out, the preparation of the extensive plan, which is now being put into effect—is, in fact, nearing completion—had to be undertaken by Mr. Henry E. Stilgoe, M. Inst. C.E., the present Engineer-in-Chief to the Board.

It is impossible, of course, in an article such as this, to set out in detail the manifold ramifications of Mr. Stilgoe's scheme, which formed the subject of a report made to the Board in 1920, and were embodied in their entirety in a Bill presented to Parliament in the course of the following year, when it passed through both Houses and received the Royal Assent. Briefly, however, the main features may be summarised as follows :—

(*a*) To provide additional mains to supply water from the Board's filtration works in the Thames Valley ;

(*b*) To provide additional service reservoir capacity at as great an elevation as possible ;

(*c*) To provide for the supply of additional water at suitable points within the Metropolis ; and

(*d*) To make it possible to deliver Thames water considerably further eastwards into Essex and Kent than had previously been feasible.

To give one example of a benefit to be derived from the new works, it is now possible, or, at any rate, it will be when the Queen Mary Reservoir and the new installation of filters at Walton are in full service, greatly to relieve the demand made upon the wells in the Kent District, which have been called upon, of recent years, to supply water further and further to the westward. The importance of this matter will be fully appreciated by those who know to what extent the level of the water in the chalk has been falling for very many years now. Then again, by means of another linking up main, a further supply of river Lea water can be delivered into the Woodford Reservoir on the east side of the Lea Valley, this additional supply of Lea water being obtained by replacing Lea water at present supplied to the central metropolitan area by Thames water. These two examples, though, of course, they are far from setting out in full the advantages which accrue from the new extensions to the Board's supply network, give some idea of the directions in which improvements have been made.

A few words may now be said as to the effect which the addtional supply from the new reservoir will have on the Board's system as a whole. It is estimated that during a week of maximum demand the Queen Mary Reservoir will afford a maximum daily supply of 134 million gallons. Of that quantity about 49 million gallons will be discharged into the Staines Aqueduct and passed on to Hampton, while 85 million gallons will flow through the new conduit. After filtration at Kempton Park about 45 million gallons will be supplied to the Northern and Western Districts by a new main laid alongside the previously existing 42in. Staines communication main. The 16 million gallons per day of Staines water supplied through the 42in. communication main and the 8 million gallons of Staines water now supplied to the Finsbury Park Reservoir, through the eastern 36in. main, will be diverted to Hampton, except as to 1 million gallons obtained from the Hanworth gravel, and these quantities will, respectively, be replaced by water from the Queen Mary Reservoir. The balance of the water from the latter will be passed on to Hampton. Of the 16 million gallons per day now supplied through the Staines 42in. communication main, 4 million gallons will go to the Kidderpore (Hampstead) zone, and 12 million gallons to the Fortis Green Reservoir, the distribution being effected from the Cricklewood pumping station. Of the additional 45 million gallons to be supplied to the Northern and Western Districts, 8 million gallons are to be allocated to the zone served from the Ealing Reservoirs, 17 million gallons to the centre of the Western District by way of the Edgware-road, and 20 million gallons to the Northern District. To enable these quantities to be delivered it has been necessary, beyond providing further filter beds and pumping stations, to lay additional pumping and distributing mains and to construct further service reservoirs.

The whole scheme for the augmentation of the Board's resources, rendered possible by the construction of the new reservoir, provides for a daily supply of 372 million gallons for the entire area under the control of the Board during the week of maximum demand, and with an average supply of 45 gallons per head per day, that quantity will suffice for a population of about 8,267,000. In such a period of drought as that which occurred in 1899, however, and under the conditions of abstraction from the Thames provided for in the Thames Conservancy Act of 1911, the capacities of the existing reservoirs and wells—including that of the Queen Mary Reservoir, and taking into account also the yield of the wells in Kent recently sanctioned or sunk, would be on the point of exhaustion in affording such a supply. Fortunately, such droughts as that of 1899, though to be reckoned with as contingencies that may have to be faced, are of rare occurrence.

We have to acknowledge our indebtedness to Mr. Henry E. Stilgoe, the Water Board's Chief Engineer, for his courtesy in affording us facilities for visting the works at various times during the period of construction and for the drawings and photographs from which the accompanying illustrations have been prepared. We also desire to express our thanks to several engineers on Mr. Stilgoe's staff, both on the site and in the offices of the Board, for the helpful assistance they have given to us in the preparation of this article.

Notes on British Railways by a Continental Engineer.

No. I.

A Few Comparisons.

The author, as a consequence of functions held for many years, has had occasion to examine in detail the organisation and operation of the railways of the United Kingdom. He desires to give a *résumé* of his observations and to compare impartially British railways with those of other countries. In railway matters every nation has its own habits, its own traditions, its own regulations, and even, let us say, its own routine, from which it is necessary to detach one's self to appreciate properly the activities of others. From this point of view an exchange of ideas is always desirable, and cannot help being both useful and profitable. Inventions, for example, which are found in a given type of engine or in particular apparatus may be rapidly generalised under identical forms, or at least very similar forms, whilst the railway, very complex in its nature, embracing whole countries, and representing immense capital, does not lend itself to similar treatment, but assumes in each country something national and independent, according to the diverse resources, the needs, even the temperament, of the race, or the *rôle* of the State towards them.

The railways of Great Britain, far from having escaped from this law, have perhaps more than any other received the impression, the indelible trade-mark, which these tendencies give. They occupy a place apart, having been conceived, established and developed according to methods often very different from those of other countries. Some of these methods may surprise the stranger, familiar with a different regime, and unable at once to adapt himself to the new conditions ; but if he is not animated by any prejudices, he will not be slow to recognise the great facilities which are given to travellers in the United Kingdom, and to appreciate that the railways were really created for, and are conducted with, the object of providing regular and efficient public services. The more he travels in all directions the more will he be impressed with the homogeneity of the system, in spite of the existence of many companies ;* the attention to detail which is exhibited by the various systems ; the abundance of modern rolling stock ; and a degree of standardisation which results in the existence of far less difference between the main lines and the secondary lines, than is found in other countries. This opinion will be even more favourable to one who has known the railways in earlier days, at an epoch when, in view of their rapid development, they adopted innovations and displayed an activity which was not then found elsewhere.

The railway systems of Great Britain, tightly interlaced and interconnected, are the seat of a very considerable traffic. Many of the great main lines from the North and the West reach London on four roads, some of which were constructed as much as forty years ago. The junctions at certain points are of a complexity which is scarcely to be found in other countries. It must never be forgotten that the United Kingdom is not a country of long distances, such as are found in Russia or the United States. There is scarcely any express journey which occupies more than nine hours and the mean main line journey is less than three or four hours ; certain railways are, in reality, suburban lines. But it is not the length of journeys that has to be considered here, but the density of the system and the dispositions which are taken, above all on the Northern and Western lines, to make travel in all directions short and quick. The bulk of the express traffic takes place between London, Liverpool, Leeds, Sheffield, &c., and it is therefore less necessary for the companies to provide luxurious passenger stock than to make all arrangements to assure quick, regular and frequent communication between the great cities with the maximum of comfort that is demanded for a relatively short journey.

England is the pioneer of railways, and for the first years remained the incontestable master. But the railway development of other nations was soon effected and the immediate British influence was no longer felt, save on a much smaller, though still very important scale—especially from 1872 to 1890 by the adoption of the block system and interlocking, and the application of the bogie to carriages and engines. Owing to this priority and to certain other causes which I shall examine, Great Britain has shown for a long time a superiority which it would be unfair to deny. The great expresses of France and America are to-day quite as fast and heavier than those of England, but it is nevertheless true that speed was the exclusive appanage of the latter from the beginning, for a good many years. If other nations have in many respects recovered lost ground, which they certainly have done, they have only accomplished progress which had before existed in England. In other words, the same problems had presented themselves much earlier in England than in other countries, and were solved once for all by improvements, some of which were not adopted till much later by other nations. Some of the latter, at least by reciprocal effect, furnished solutions which were ultimately accepted in Great Britain. Thus, it seems probable that America suggested the general employment of the bogie, both for locomotives and for carriages, and gave the first idea of vestibule trains, whilst the Continent, and France particularly, introduced coaching stock with lateral corridors.

Moreover, the speeds of the great expresses alone are not all—far from it—and it is probably correct to affirm that England has remained the country in which the mean speed of all trains and the general acceleration of service is still the highest ; she possesses also—indeed, she was the first to possess—crack trains. But that which distinguishes British railways is less the superiority of certain special services than the high standard of the average service. That is the main question, and there can be no manner of doubt about it when one considers the road and signalling system, as well as the average speed and the number of trains which spread in all directions throughout the kingdom. Furthermore, it is not speed alone which has to be considered, but the conditions in which it is realised—the smoothness of travel, the absence of shock at the joints of rails and at crossings, which are attained by British companies. These companies, until recently, have given greater attention to the multiplication of the number of trains than to the considerable increase of their weight. Indeed, the length of the trains is limited by that of certain platforms, although generally the great British railway stations are, even the oldest of them, remarkable for the length of their platforms, which exhibit the far-sightedness of their constructors. There is, however, a limit to the frequency of trains, which was reached long ago on certain systems and several companies have been obliged, as elsewhere, to increase the weight of their expresses, not only to meet augmentation of traffic, but also to satisfy the ever-growing demand of the public for more comfort, and also to secure more economical working. But passenger trains, weighing five to six hundred tons, which are not rare in France, and, *a fortiori*, in the United States, are very exceptional in England. The conditions which are imposed elsewhere are not even desirable for Great Britain in my opinion.

The rapid development and modernisation of British railway systems, notably from 1865 to 1890, was due to many causes, amongst which the following may be cited :—The density of population, the predominance of city population, and the great number of large cities and maritime ports, but, above all, an industrial evolution which preceded that of other countries, and an immense mineral traffic—the United States, France and Germany were still mainly agricultural countries up to 1871, and their manufacturing industries have developed in a great measure more recently—and, finally, an innate mechanical temperament. One ought to take particular note of the large number of towns of over 200,000 inhabitants often close together, which arose with the industrial epoch, and it should be observed that the great railway systems—Great Western, London and North-Western, Scottish railways, the Midland, the North-Eastern, &c.—covered important mineral areas. The Lancashire and Yorkshire Railway, which does not reach London, traverses a region which is, so to speak, but one city and one factory.

From what has been said already, it will be seen that if the railways of the United Kingdom have apparently not accomplished in the last generation as much progress as other countries, it is because there was less left to them to do, as they had already reached a degree of improvement which even now, from many points of view, is not to be found elsewhere.

The stranger who arrived in London about 1875 might witness a spectacle then new to him, and contemplate a maze of rails and junctions, even then almost as complex as to-day, and traversed by a great number of trains, notably to the south of the capital. The construction of Charing Cross and Cannon-street Railway Stations and their connections to the heart of the city in 1863 and 1866 respectively, and that of the Metropolitan Railway in 1863, were very remarkable innovations for the epoch in which they were built.

The railways of Great Britain were developed under a financial system which possesses great relative liberty but is controlled by Parliament. Parliament, whilst examining all Acts with great care, permitted, notably in the last century, competition of

* Since 1922 the railways have been collected into four great groups, but in such an examination as this it is convenient to observe the old distinction into separate companies.

which the effects were excellent. This competition tends to disappear nowadays when things are settled down and tradition and habits are fixed. Furthermore, the rivalry between railway companies was more profitable to the public than to the companies themselves. Whilst certain of them made arrangements between themselves, matters never went so far as in the United States. The system is indeed intermediate between the American system and the Continental State system.

I have had occasion to indicate that the development of railways was facilitated in Great Britain by various causes, for example, by its insular position. The construction of strategical lines which put such a heavy burden upon continental systems was obviated. Again, the absence of internal custom houses, which complicate very greatly the delivery of goods and merchandise, was unknown.

The law for the expropriation of property for the public good not existing in England, the companies were able to buy from the first, sometimes under very onerous conditions, the ground that they required. Since then, laws have been established for settling the value of property by arbitration. Nevertheless, the capital charges on English railways are heavy, but, in compensation, the railway companies are the sole owners of the property, whilst the French railway companies, for example, work, for the most part, lines constructed by the State or at its expense, and are virtually proprietors only of the material. But if they are compelled by law to give services on certain secondary lines which only result in a financial deficit, at least the interest on their capital is guaranteed by the State. The British companies are characterised by their industrial nature, whilst the railways of continental Europe have become by degrees real administrations and their servants more or less functionaries of the State.

The accountancy of British railways permits them to write off pretty rapidly their rolling stock and, consequently, to renew and to modify it more frequently than is possible in some other European countries. Of course, continental administrations perfect their material, often on a very fine scale, but the secondary lines have then to receive the old stock, if it is not distributed amongst the stopping trains here and there. In England, renovation is not limited to the engines and coaching stock of the principal lines, at least within certain limits. At any rate, one should observe the general adoption of modern bogie stock for all classes of trains and in all parts. Centralisation, which exists in certain continental countries, is not found there. Some entire networks which do not terminate at London,* are not at all of a provincial character, and are sometimes best provided, but they are found, above all, in the rich mineral and industrial districts. Hence we find in England a democratisation of comfort and its general adaptation to third-class vehicles. The traveller of that class is treated perhaps with more respect than in any other country, but it is only right to add that in no other country is he more worthy of it. It seems, moreover, that the real labouring classes are less given to travelling than similar classes of the community in the Western regions of the Continent. It is interesting to note a similar tendency in France, where in recent years more third-class than first-class vehicles have been constructed and always of the most modern design. The result is a paradoxical fact that in certain secondary trains and on certain railways, third-class passengers have at their disposal more modern and comfortable accommodation than that which is provided for the first-class passengers. Of course, this is due to the transitional nature of the period, but it may endure for some time yet. In any case, it is curious to note that on the Continent there has been a brusque transition from inferior third-class vehicles to fine bogie corridor stock and well-padded seats, in sharp contrast with the antique vehicles which even yet enter into the composition of trains on branch lines, or even of stopping trains on the main lines. Such a contrast is not found in England, the old rolling stock having been suppressed long since. In that respect, Great Britain led, as it did also in including third-class coaches in the composition of express trains. It is interesting to compare this largeness of view with the German system, which demands extra payment for express trains.

On the other hand, the English railways have had to pay, often at a high rate, for the advantage of being the precursors. Consider, for example, the general adoption of high platforms, which are so much to be desired elsewhere, the restrictions imposed both as to height and width by the British loading gauge, which is much less than that of the normal lines of other countries, and which, despite the remarkable ingenuity displayed by engineers, has prevented the employment of vehicles as high and as wide as those recently adopted on the Continent, not to speak of America. But English trains owe their uniformity in part to the limitations which have been enforced by the loading gauge, superintendents having from the start made vehicles up to the maximum possible dimensions, whilst in the rest of Europe it was not till much later that the limits were reached. This is the reason why one so frequently sees on Continental trains other than the great expresses, composed of ancient and modern vehicles, differences of height and width which are unpleasing to the eye. Such irregularities, for example, as imperial double-deck cars,* the watch-boxes for the brakesmen or conductors, and air reservoirs for brakes placed on the roofs of carriages. I shall speak later of this characteristic feature of British trains—their homogeneity and cleanness of line.

The limitations of the loading gauge have placed greater difficulties in the way of the increase of power of locomotives, but they have been far less obstructive than one might have imagined, and may have probably contributed, with other causes which will be examined later on, to the extreme compactness of locomotives, which are the most powerful *per unit of adhesive weight* in the world, a desirable feature in locomotive design. But it is to be remembered that the method of railway organisation which is employed in England, a subject which will be discussed in more detail later, does not in general call for such powerful locomotives as are required by certain Continental lines, still more by American railroads. The Great Bear on the Great Western was used but little for many years, and it is only recently that the "Pacific" type has been practically developed. In order to use these locomotives to their best advantage, it is necessary that they should be normally, if not always, employed to haul trains of a weight which justifies their power; but it is probable that in England, as elsewhere, the day will come, sooner or later, if it has not already come, when great ingenuity will be required to solve the problems within the imposed limits. In France on all systems, the "Pacific" type of engine, with a grate area of 47 square feet, has become the standard type for all express trains, which are frequently extremely heavy, but it is no longer a question only of 4–6–2 locomotives, for there already exist several 4–8–2 engines for express services.

In all matters which concern the strength of the road, signalling and all questions of safety in general, British railways had, until recently, to submit to the control of the Board of Trade—the duties of which have now been taken over by the Ministry of Transport. The requirements of these official bodies are greater than in other countries, because the expense has not to be met out of the State budget. It is certain that this control has had a marked influence on the permanent way and upon the general adoption of the block system, but it is possible that it has gone a little far in this respect, as many secondary lines have received the same attention as main express lines. Nevertheless, the public can only congratulate itself upon a fact which has led to that homogeneity of British railway systems to which reference has been made.

A remarkable characteristic of British railway companies is that, for the most part, they construct their own rolling stock, locomotives, signalling apparatus and so on, whilst foreign companies, both in Europe and the United States, generally purchase their material from private makers. The works at Swindon and Crewe are typical examples of railway shops. This traditional practice shows that the railway companies are conducted on industrial lines, and that they can produce material as economically as the trade makers. As a result, the private locomotive builders of the United Kingdom look to foreign countries and the Colonies for their clients, whilst at the same time building for those British railways which are too small to own their own workshops, or, in cases of urgency, supplying the greater companies. On the Continent, on the other hand, the railway workshops, although often of large size, are practically wholly engaged on the repair and upkeep of material, only from time to time constructing locomotives in order to create new types or classes. After the war, in view of the immense quantity of rolling stock, and the thousands of locomotives which had to be repaired, they had to seek the assistance of the private firms.

In succeeding articles I shall examine in more detail the principal points to which allusion has been made in what has preceded.

* A parallel case in France is that of the Midi Railway.

* Now disappearing on the suburban lines in France and superseded by large bogie vehicles on electrified lines. They will very soon be a thing of the past.

In the course of a paper on "Cellulose Enamels," read before the Oil and Colour Chemists' Association, and reported in the *Chemical Trade Journal*, Mr. A. E. Lain said that the principles of manufacture were the same as for oil enamel production, and that he had found the following proportions of nitrate, resin and plasticide satisfactory for this work:—Cellulose nitrate, 12; resins, 6; and plasticide, 2. The greater the ratio of pigment to medium, the weaker the film and the less glossy it would be, and the best method was to keep the pigment content as low as possible so that the film dried glossy. The incorporation of the pigment into the medium was somewhat difficult because of the high volatile content of the medium. Formerly the pigment was ground in castor oil or a liquid plasticide. That was wrong for two reasons; first, it resulted in a too high plasticide content and formed a soft film; and second, the maximum dispersion of the pigment in the medium could only be obtained by grinding the pigment in the medium. If it were ground first in castor oil or plasticide, and then thinned with the medium, the dispersion could not be as good as if they were ground together. Cone mills had been used but not found satisfactory, and the double roller mill was being used. Ball mills were being used extensively in the United States for the production of motor car enamels.

Involute Internal Gearing.

By H. WALKER, B.Sc.

No. I.

INTERNAL gearing represents but a small section of a highly specialised branch of engineering. Compared with the number of external gear wheels used, the proportion of internal wheels is very small. The use of the internal gear has, however, spread rapidly during the last few years, and it is becoming more and more apparent that it forms a much more highly efficient drive than the external. Whilst it has many advantages, it also has its limitations, but it is probable that the present non-universal application of the internal gear wheel is less due to its limitations than to the fact that a limitation, unless carefully watched, is apt to grow into a prejudice, in which case the limitation is often considered to apply to cases in which it has no bearing. More co-operation between the designer and the specialist would doubtless indicate that the internal gear wheel would be found to apply excellently in cases in which it would otherwise have been overlooked.

The present article is intended, as far as compatible with limits of space, &c., to present internal gearing from a new point of view, and to expound a new method of design which largely avoids present internal gear difficulties. The article is divided into four sections: the first is devoted to a comparison between the internal and the external gear wheel; the second deals with a new method of design for internal wheels; the third is concentrated on cutting the gears; and the fourth discusses the problem of trochoidal interference.

COMPARISON OF INTERNAL AND EXTERNAL GEAR WHEELS.

Apart from such obvious advantages possessed by the internal gear as short centre distance and compactness of design, and such disadvantages as are imposed by the fact that a pinion and internal wheel can usually be supported by bearings on one side only, the chief differences between the two types of gear centre round the tooth action and the cutting process, and it is to the two latter factors that the present discussion will be confined.

Cutting methods are dealt with in another section, and we need only here be concerned with a brief comparison between the cutting methods for internal and external gear wheels.

It may be said immediately that the present methods for cutting internal wheels are, excepting the gear-shaper method, which is limited to gears of small and moderate sizes, inferior to the methods for cutting external wheels. The three chief processes for cutting external wheels are hobbing, generation from a cutter of rack form, and the gear-shaper process. All three processes are generating methods, but for very large gears a non-generating process is often resorted to, such as that of milling the teeth with a formed cutter, or planing them with a tool which is made to follow the correct path by means of a former. The first three methods are, however, those commonly used, and only the last of them, the gear-shaper process, has been applied to internal gears. A hobbing process, making use of a short hob, is sometimes used for internal gears with large numbers of teeth, but it can hardly be called a generating method, since the hob is usually shorter than the length which would be required for effective generation, and consequently the teeth are formed rather than generated.

Whilst the gear-shaper process answers excellently for gears of small and moderate sizes, it has not yet been applied to larger internal gears, which must therefore be cut by a forming process, the usual method being either to slot the tooth spaces with a cutter formed to the correct shape, or, where possible, to mill them with a rotary milling cutter. Both these latter methods have a disadvantage in the difficulty of ensuring that the tool is of the correct shape, and the further disadvantage that errors in setting the tool are reflected in the accuracy of the gears. The cutting time of the forming process is also greater than that of the generating process. The gear-shaper method has the advantage that it automatically cuts out the interference portion, if any, of the profile, and also that accuracy in the cutter is ensured by grinding it on the profiles by means of a generating process.

It may be concluded from the above brief comparison that small and moderate sized internal wheels may be cut rapidly by a generating process, whereas larger internals must be cut by a forming process which necessarily takes a longer time and requires great accuracy in cutting.

TOOTH ACTION.

The relative tooth actions of internal and external gear wheels will now be considered. The usual text-book method of making a comparison between internal and external action is to show that the effective line of action is longer in the former than in the latter, and that the relative slippage between the profiles is less for the internal than for the external, from which it is concluded, without stating the precise effect of these factors, that the wearing properties of the internal are superior to those of the external

wheel. The two advantages mentioned are, however, not sufficient in themselves to justify superior wearing properties. Let us examine them in detail and see exactly what does take place.

Fig. 1 shows the pitch lines, outside diameters and root diameters of a pinion gearing with an external and an internal wheel. B O A is the line of action, and it is obvious that if the pinion is driving in the direction of the arrow, the last point of contact between a pair of teeth of either the pinion and the external wheel or the pinion and the internal wheel is at A, where the line of action meets the outside diameter of the pinion. The first point of contact between the pinion and the external wheel will be at C, where the outside diameter of the gear meets the line of action, and the first point between the pinion and the internal wheel is at B, where the line of action is met by the internal diameter of the gear. Thus for the pinion and external wheel the effective length of the line of action is A C and for the pinion and internal the length is A B. Now the number of teeth in contact at the moment depends on the length of these lines and on the position of the teeth. If a tooth of the pinion is in contact at C, and if the next tooth O be drawn in position one pitch away, the length C O, the intercept between two consecutive teeth as measured on the line of action, is equal to the base pitch of the gear, *i.e.*, the pitch of the gear as measured on its base circle, and this length is constant for any position of the profiles and for all three gears.

This consideration enables tooth load diagrams to be drawn—as in Fig. 2. Taking the left-hand diagram first, which is for the pinion and the internal wheel, the base B A_2 represents—to an enlarged scale—the effective line of action B A in Fig. 1. The lengths B M and A_2N are measured off equal to twice the base pitch of the gears, and it will be obvious that while the point of contact for a pair of teeth is travelling from B to N two other pairs of teeth will be contacting somewhere between N and A_2, but when the point N is reached one of the other pairs of teeth will have reached A_2, and therefore from N to M two pairs of teeth will be in contact. When the point M is reached, a further pair will be commencing contact at B. Thus from B to N and from M to A_2 the load is shared by three teeth, and from N to M by two teeth.

In the same way the right-hand diagram shows the loading for the two external wheels. In this case the length of the line of action is less than two base pitches, and consequently the lengths C M and A N must be made equal to one base pitch, so that from C to N and from M to A the load is shared by two teeth, and from N to M the load is sustained by one tooth only.

Assuming, for the moment only, that the amount of wear is proportional to the load, and neglecting the effect of sliding, &c., the diagrams may be taken to represent the amount of wear at points on the profile of a tooth corresponding to the position at which any ordinate is selected. Since, however, the profiles cannot wear unevenly—this would result in increased load on the unworn part of the profile, thus maintaining a balance of wear for the whole profile—a line of mean height may be drawn across the diagrams to represent the wear. The difference for the particular cases under consideration is very marked, but for many ratios the change from external to internal is not always sufficient to bring another tooth into action as in the instance illustrated, and in such cases the effect of load will not be so great.

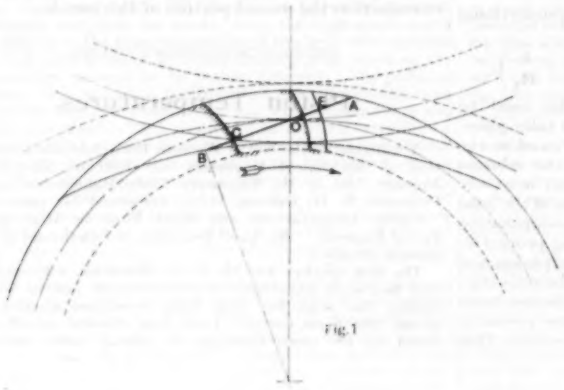


Fig. 1

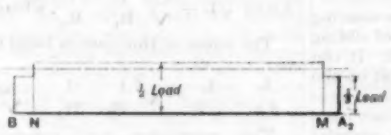
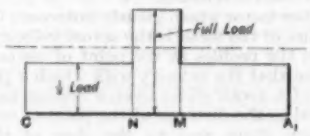


Fig. 2



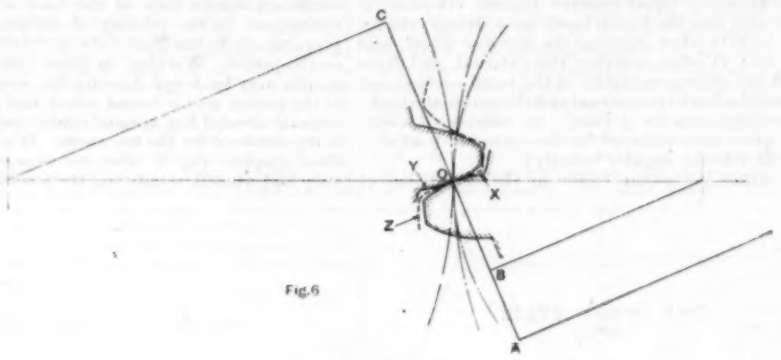


Fig. 6

Fig. 3

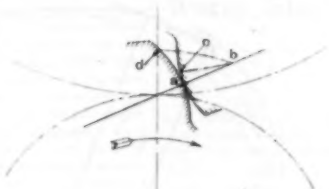


Fig. 4

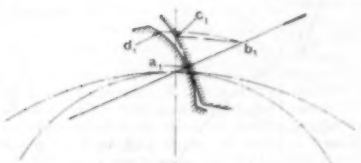


Fig. 5

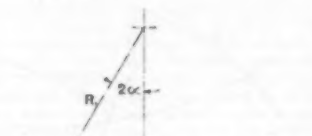


Fig. 7

"THE ENGINEER" Swain Sc.

We now come to the effect of slippage between the profiles. Considering the pinion first, as being the gear liable to wear out most quickly, Fig. 3 shows the pinion profile in two positions, one when in contact at *a* and the other when in contact at *b*. It is obvious that in moving from *a* to *b*, the contact has passed over the surface *a c* of the pinion face, and that whatever the disposition of the mating gear, nothing can alter the fact that this portion of the profile has been subjected to a certain action under a definite load, and this action depends on nothing except the amount of the load. Now the load has been accounted for in the comparison diagrams in Fig. 1, and consequently the effect of slippage* will have no effect on the present comparison as regards the pinion. The effect of the movement of the mating profile will, however, be reflected in the lubrication of the surfaces, since the velocity of rolling will vary; but so little is known concerning the effect of this factor on lubrication that it can only be summed up by the general remarks given later. Moreover, since the present purpose is mainly a comparison, the factor will have little effect on the accuracy of the results obtained.

As regards the wheel, however, slippage plays a more important part, since the effective length of profile will be greater for an internal than for an external wheel, and the load will remain concentrated on parts of the external tooth longer than on the corresponding parts of the internal tooth. Thus in Fig. 4, during the passage of the point of contact

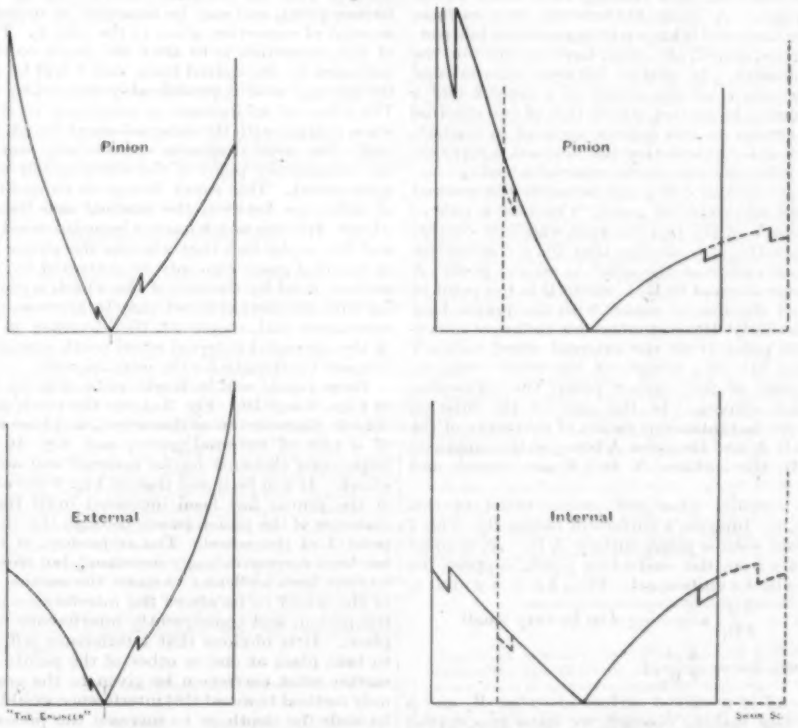


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FIG. 8—COMPARATIVE WEAR OF PINIONS AND WHEELS

* By slippage is meant the relative length movements of the profiles, and the value of this ratio has no connection with the velocity of sliding.

from a to b the portion $a\,d$ of the pinion profile passes over the portion $c\,a$ of the wheel profile, and in the case of the internal wheel—Fig. 5—the same length $d_1\,a_1$ of the pinion profile passes over the portion $c_1\,a_1$ of the wheel profile. If the steps $a\,b$ be taken very small, it would be reasonable to assume that the comparative amounts of wear on the two wheels at corresponding points on the lines of action are inversely proportional to the lengths of profile utilised during these movements.

Another factor which greatly influences the wearing properties of the teeth is the actual velocity of sliding between the profiles at the point of contact. It can be shown that the velocity with which a point on the profile of a tooth slides over a mating tooth is proportional to the distance of the point of contact from the pitch point and to the sum of the angular velocities of the gears. Thus in Fig. 1 the sliding velocity at the point E is proportional to the length O E. Assuming equal relative angular velocities, it will be seen that the pinion tooth has a sliding velocity equal to B O when entering the internal wheel, and equal to C O when entering the external, and from C to A the sliding velocities of the tooth surfaces are the same for both the internal and the external wheels. (These values would, of course, be different if a constant speed were assumed for the pinion instead of a constant relative angular velocity).

A further important factor in the estimation of wearing properties is the degree of closeness with which the tooth surfaces envelop each other at the contact point. A close fit between two surfaces spreads the load, and is known to improve the lubricating properties, which, of course, have an effect on the wear. Moreover, the contact between internal and external wheels is of the nature of a convex and a concave surface in contact, whilst that of two external wheels is similar to two convex surfaces in contact, from which it is obvious that the internal is superior, from this point of view, to the external wheel.

Fig. 6 shows the difference between the contact for internal and external gears. Consider a pair of teeth X and Y of the two external wheels in contact at any point O. It is obvious that the instantaneous radius of curvature of the point O on the profile X of the pinion is equal to B O, where B is the point of tangency of the line of action with the pinion base circle. Similarly, the instantaneous radius of curvature of the point O on the external wheel tooth Y is C O, and the two centres of curvature being on opposite sides of the contact point, the contacting surfaces are convex. In the case of the internal profile Z, the instantaneous radius of curvature of the point O is O A, and the point A being on the same side of O as B, the surfaces X and Z are convex and concave.

Let us consider what the precise effect of this curvature is. Imagine a surface of radius R_1—Fig. 7—in contact with a plane surface A B. At a small distance $\delta\,y$ from the contacting point, suppose the surfaces to be $\delta\,x$ units apart. Then $\delta\,x = \delta\,y\,.\,\tan\alpha$, and $\tan\alpha = \dfrac{\delta\,y}{2\,R_1}$, assuming α to be very small.

Therefore, $\delta\,x = \dfrac{\delta\,y^2}{2\,R_1}$.

If, instead of a curved surface of radius R_1 and a plane surface making contact, we have two curved surfaces of radii R_1 and R_2, it is obvious that the distance $\delta\,x$, by which the surfaces are apart at a distance $\delta\,y$ from the touching point, is equal to $\dfrac{\delta\,y^2}{2\,R_1} + \dfrac{\delta\,y^2}{2\,R_2}$, the values of R being reckoned positive if convex and negative if concave. Thus we have

$$\delta\,x = \tfrac{1}{2}\,\delta\,y^2\left(\frac{1}{R_1} + \frac{1}{R_2}\right).$$

and $\delta\,y = \sqrt{\delta\,x} \div \sqrt{\left(\dfrac{1}{R_1} + \dfrac{1}{R_2}\right)}$.

Making the assumption, which will be sufficiently close for the present purpose, that $\delta\,x$, the distance through which the surfaces close when placed under a load, is proportional to that load, then it follows that the width of the flat $(2\,\delta\,y)$ on which contact takes place is governed by the proportionality of $\delta\,y$ to $\sqrt{L} \div \sqrt{\dfrac{1}{R_1} + \dfrac{1}{R_2}}$, where L = load.

The stress on this narrow band must be proportional to

$$\frac{L}{\delta\,y} = \frac{L}{\sqrt{L}} \times \sqrt{\frac{1}{R_1} + \frac{1}{R_2}} = \sqrt{L\left(\frac{1}{R_1} + \frac{1}{R_2}\right)}.$$

This expression may consequently be used to represent the amount of wear which will take place.

So far, then, we have the wear proportional to the combined square root of the load and the relative curvatures, to the velocity of sliding, and inversely proportional to the degree of concentration of the load on the profile. Working on these lines, comparative graphs may be drawn showing the wearing properties of the pinion and external wheel and the pinion and internal wheel of Fig. 1, equal relative angular velocities being assumed for the two cases. It will be seen from these graphs—Fig. 8—that the wear of the pinion is very bad when it is entering the internal wheel. This result is due to the fact that the pinion comes into contact with the internal wheel almost at its interference point, and may be remedied by increasing the amount of correction given to the pinion. The result of this correction is to alter the graph to the limits indicated by the dotted lines, and it will be seen that the average wear is considerably reduced by so doing. The effect of an increase in correction to the pinion when gearing with the external wheel would, however, make the wear diagrams considerably worse, since the interference point of the wheel would be rapidly approached. This result brings us to another point of difference between the internal and the external wheel. It is one which has not been discussed hitherto, and lies in the fact that whereas the pinion of a pair of external gears can only be corrected by a limited amount fixed by the size of the wheel, a pinion gearing with an internal wheel may be given an unlimited correction, and, moreover, the decrease in strength of the corrected external wheel tooth changes to an increase in strength for the internal gear.

These points will be made quite clear by reference to Figs. 9 and 10. Fig. 9 shows the pitch diameters, outside diameters, root diameters, and base diameters of a pair of external gears, and Fig. 10 the corresponding elements for an internal and an external wheel. It will be noted that in Fig. 9 the addendum of the pinion has been increased until the outside diameter of the pinion passes through the interference point I of the wheel. The addendum of the wheel has been correspondingly decreased, but this decrease has not been sufficient to cause the outside diameter of the wheel to lie above the interference point i of the pinion, and consequently interference must take place. It is obvious that interference will continue to take place at one or other of the points I or i no matter what correction be given to the gears. The only method to avoid this interference would be either to stub the depth or to increase the pressure angle of the gears.

Referring now to Fig. 10, it will be seen that the internal diameter of the wheel has been increased so that it passes through the interference point i of the pinion, and consequently interference will be just avoided. Moreover, the interference point I of the internal wheel lies inside the internal diameter, and therefore interference cannot take place here. The greater the correction the further will the interference points be removed from the centre of action.

It follows from this result that a considerably lower pressure angle may be used for internal gears than for externals, without interference taking place and without decreasing the tooth strength. Fig. 11 shows the comparative strengths of an internal and an external tooth, both corrected by the same amount. It is obvious that the pressure angle of the internal wheel may be greatly reduced before its strength is lowered to that of the external tooth.

The possibilities opened up by these facts will be examined in the second portion of this article.

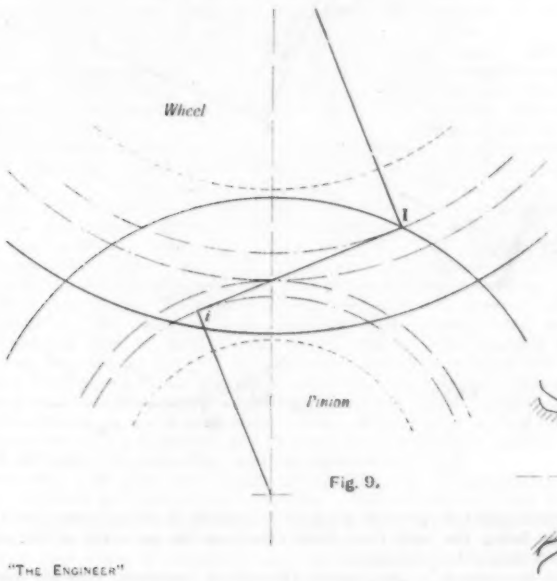

Fig. 9.

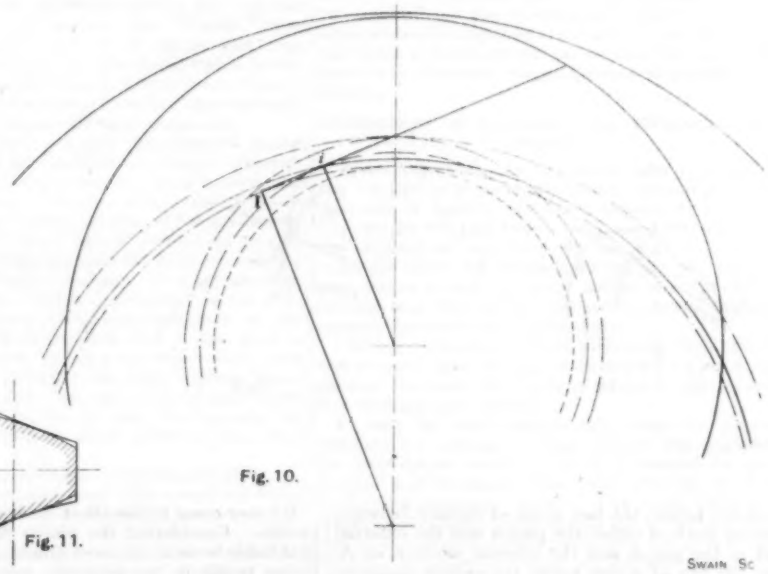

Fig. 10.

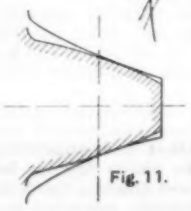

Fig. 11.

Piston Temperatures.

A MEETING of the North-Western Branch of the Institution of Mechanical Engineers was held on Thursday, January 21st, at the Engineers' Club, Manchester, when Professor A. H. Gibson, D.Sc., presented his paper on "Piston Temperatures and Heat Flow in High-speed Petrol Engines." Mr. Cecil Bentham, the chairman of the branch, presided.

The first speaker was Mr. G. E. Windeler, who said he had had some experience with aluminium pistons when, during the war, his firm built aeroplane engines of about 300 horse-power. Cast iron pistons would not stand up for more than ten to fifteen hours without trouble, and the company had started making aluminium pistons. Its first mistakes were to make them too thin. As a matter of fact, with aluminium it was necessary to make the piston very much heavier in section than with cast iron. The company had made pistons of 12in. diameter and 17½in. diameter, and with the 12in. piston, which had been running for a period of about six years on many engines, the results were satisfactory. It was too soon to speak about the results obtained from the larger pistons, but there was no doubt that the piston friction had been materially reduced in the larger engine by the cooler surfaces and the lesser possibilities of the destruction of the oil film, because that particular engine—600 horse-power—showed an extremely low fuel consumption. There was, however, another important point in connection with piston design, and that was the size of the cross section of the piston ring itself, and the number of rings. At one time his firm used five or six rings in a piston of 12in. diameter; to-day three were found sufficient. Professor Gibson had referred to the possibilities of increasing friction and the resultant breakdowns of piston, because of the removal of the oil film. That was true. Pistons showed distinct signs of abrasion on their surfaces soon after the lubrication was reduced. There was another defect which would cause friction, and that was the too close butting of the rings themselves. He had known cases where seizure after seizure had taken place on a piston which had all the necessary mechanical clearances which it should have, and which should have enabled it to run well and without seizure; and it had been only after making careful examination of the piston rings themselves and by reason of the surface of the piston ring rubbing on the walls that it had been found that the piston rings were butting together and causing severe friction. There was a little point in connection with aluminium pistons which was important; it was undesirable to fix the gudgeon pin itself in the piston, because the aluminium was not very strong, and the difference of expansion of the gudgeon pin and the piston would cause severe distortion. His firm used a floating pin, which could rotate freely as the connecting-rod oscillated. In regard to the piston rings, remembering the amount of friction that might be produced on a ring at the compression pressure, it was not advisable to have the ring any wider than was necessary to keep a decent oil film on the cylinder walls. The extreme practice of fitting piston rings as thin as $^1/_{16}$in. had not been satisfactory. On a 12in. piston the ring should be not more than ¼in. wide, and on a 17½in. piston about $^7/_{16}$in. wide.

Mr. E. T. J. Kersey said Professor Gibson had made some fairly simple assumptions in the theoretical portion of the paper. He (Mr. Kersey) had no quarrel with the conclusions, but from the way in which the heat was being transmitted to the piston and through the piston, it

seemed to him that the conditions were very complex indeed. Heat was radiated from the exhaust valve and from the burning gases, and also carried by convection, and the rate at which it was transmitted in the two cases would be very different. He found it very difficult to see how Professor Gibson estimated the quantity of heat transmitted to the walls and to the oil film. He would like to know what proportion of the heat which was transmitted from the piston was sent to the walls and to the oil by conduction from the inner surface of the piston. In an earlier paper Professor Gibson had emphasised the fact that a considerable portion of the heat was abstracted from the piston by means of evaporation of the oil. It seemed to him (Mr. Kersey) to be rather an extraordinary fact that his results from the high-speed petrol engine as to the total proportion of the heat corresponded so well with those of Professor Gregory and others, as the conditions seemed to be rather different. The exhaust valves were in such a position with the side-by-side type that the amount of radiation from the exhaust valve was only very small. That seemed to be rather a coincidence. With reference to the burning of pistons, Professor Gibson had suggested that it was due to the breakdown of the oil film, owing to insufficient lubrication, and the heat, because of the additional friction plus the already fairly high temperature of the piston, was sufficient to melt the eutectic. Might it not be that the reduction of lubrication reduced the amount of heat abstracted by evaporation of oil from the inner surface of the piston?

Mr. Lloyd said he was very interested in the question of heat flow. His remarks were based on investigations which he had made some years ago at the College of Technology. Where the conditions on one side of the metal were such as to produce a rapid fluctuation in the surface temperature, the temperature gradient corresponding to a given flow of heat could be calculated fairly accurately, especially when the cool side was in contact with water. The temperature of the hot side was calculated in that manner, and could only be regarded as a mean cyclical temperature, and the temperature fluctuation of 5½ deg., as given on page 24, was considered by the author as being negligible. In that connection, it had been stated by other writers that that cyclical change in temperature was similar to wave motion, which died away as it passed through the metal. There was a certain interval between the time when the maximum temperature was impressed on the surface until it passed a certain point in the thickness of the metal. By making that time interval equal to one revolution of the crank—in the case of the four-stroke cycle engine—the depth corresponding to a maximum temperature difference could be obtained, the extreme temperatures then being out of phase. In a particular case, it was found that with a heat flow of 70 B.Th.U., corresponding to a temperature gradient 74 deg. Fah. in 1¼in., the temperature variations were out of phase and practically constant. Those investigations had previously been made in the case of steam engines. Although that cyclical change in temperature of the metal was small, the instantaneous maximum temperature gradient occurred in the first layer of metal, and the result in cyclical thermal stress was of a repeating nature. That, of course, was a different question from that of burning, which was considered by the author. In the expression given on page 28 for the semi-amplitude of the surface temperature, it would be seen that it was inversely proportional to the square root of the number of expansions per second. Comparing two engines therefore, one running at 2000 revolutions per minute and the other at 200 revolutions per minute, would it be correct to say that in the case of the latter the surface fluctuations were roughly as the square root of 10 was to 1, or roughly three times greater with pistons of the same material?

Mr. Telford Petrie said Mr. Windeler had mentioned the thermal conductivity of aluminium and iron. It agreed almost exactly, the conductivity of aluminium being approximately 3½ times that of iron, and the difference—see Table II.—being nearly of the order of 2 : 1 in degrees, and the thickness of the pistons being approximately 2 : 1 as well. That was interesting, because it showed how reliable the tests were from a practical point of view. He thought the most satisfactory thing about the whole paper was the feeling that engineers were not on dangerous ground with the temperature of pistons in internal combustion engines. To have that definitely confirmed was of real value. It seemed to him that careful and efficient lubrication between the piston and the cylinder walls was the means to avoid the trouble of burnt pistons.

Mr. R. Onions said Professor Gibson had not told them what was the best temperature in a four-cycle engine. Troubles, of course, arose when the temperatures of the incoming charge was increased. Radiating ribs were of little value in an enclosed engine piston. On a large horizontal engine open at the front where the air had free access to the piston a little advantage was derived from them. He would like to know why the maximum temperature was some little distance away from the centre of the piston. He had seen very large engines, 24in. cylinder, 30in. stroke, horizontal type, running at full load with pistons glowing red hot. All the time there was no premature firing, but apparently to look at the piston the maximum temperature was right in the centre.

Professor Gibson, in reply, said the alloy known as "magnesium" was an alloy of pure magnesium and about 3 per cent. of nickel. It was being used at the Royal Aircraft Establishment, and gave excellent results. It was a very much lighter alloy than aluminium, and for very high-speed engines it was giving excellent results. Its thermal conductivity was just about the same as aluminium alloys and it wore as well. He was very interested to hear Mr. Windeler's account of his own experience of pistons of considerable diameter, and to know that the skirt clearances used on those engines were about $^{12}/_{1000}$in. to $^{14}/_{1000}$in. on a diameter of 17½in. He had made a note that in modern aero-engines with diameters up to about 8in. the clearances were about 2½/1000in. The use of the floating ring was becoming fairly usual in aero-engine practice. As regarded the width of the rings, it was the practice to design the rings so that the normal pressure on the surface was about 4 lb. per square inch. The assumption that the heat flow to the piston was proportional to the square of the difference of temperature, might be contrasted with the old assumption that it was proportional to the first power of the temperature. He realised that that could not possibly be true, because, as Mr. Kersey had said, there was radiation transference and conduction transference, which must be more or less proportional to the temperature itself; there were variations of density taking place and variations of temperature accompanying it. They could not therefore take such a simple law as the first power law. Professor Gibson said he had taken the trouble to investigate as far as he could the results of Dugald Clerk and Hopkinson in addition to his own, and it was surprising how their results agreed with his formula. Mr. Lloyd had suggested that it was possible that the breakdown of the piston material was due to thermal stress. That question had not been lost sight of. He would find that the amount of stress was so small that it was not likely to be the prime factor in breakdown. Mr. Lloyd was quite right in assuming that if one took an engine running at 1000 revolutions per minute and one running at 100 revolutions per minute with the same piston, the fluctuation of temperature in the slow-speed engine would be three times as great as in the high-speed engine. The liner of the "V" type engine was steel; all the liners were steel. There was a question as to the effect of speed. When they had been making the experiments they had been concerned only with the effect of speed in a range over which an aeroplane engine was expected to operate—from 1600 to 2000. But he had data at speeds from 1000–2000 which confirmed the general results that speed in itself was not an important factor. As the speed increased the horse-power output increased, and the temperature went up somewhat, but not greatly. The engine, whose valves, &c., were designed so that it gave its full output at 1000 revolutions per minute, would not have a vastly different piston temperature from an engine designed to give 2000. Regarding the effect of turbulence, in itself turbulence did tend to increase heat flow from the gas to the surface. They had once endeavoured to find out what was the best temperature in a small engine about 4½in. diameter at high speed, and had found that the best results were obtained at about 130 deg. Cent. in the jacket.

World Steel Trade and Britain's Share.

By E. T. GOOD.

IT is now possible, from the monthly returns so far available, to give a pretty near estimate of the world's steel trade and our own share of it for the year 1925, and the figures may usefully be contrasted with those of some previous years. In considering Britain's share of this trade it needs to be noted that not only are we specially dependent on manufactures, in which steel ranks high, but that we are above all other nations dependent on huge exports of manufactures to balance immense imports of food. We ought to beat such agricultural countries as America, France and Germany enormously in steel exports, whilst our production ought to increase in some good relation to the world's output and consumption of steel. Unfortunately, we are failing alike by the test of production and by that of exports, though it may be possible in the near future to alter the relative and comparative rates of progress. There is a great future for the British steel trade, inasmuch as our capacity of production has been largely increased since the war, as we have especially favourable shipping facilities, and as the general world demand is bound to increase. Our recent failure to make adequate headway should spur us on to greater efforts. Let us glance at the statistical side. Taking first pig iron, the foundation material of the iron, steel, and engineering group of industries, we have this record:—

Production of Pig Iron, in Tons.

	Belgium.	Britain.	France.	Germany.	United States.
1883	770,000	8,100,000	2,000,000	3,400,000	4,500,000
1913	2,446,000	10,200,000	5,400,000	18,600,000	31,250,000
1925	2,500,000	6,200,000	8,275,000	10,000,000	36,250,000

Taking steel alone we have this record:—

Production of Steel, in Tons.

1883	170,000	2,000,000	500,000	1,000,000	1,600,000
1913	2,425,000	7,650,000	4,600,000	18,500,000	31,300,000
1925	2,450,000	7,425,000	7,256,000	12,400,000	45,000,000

Barely a quarter of a century ago we exported as much iron and steel as all competitors put together. That was only natural in view of the fact that we alone had ore and fuel supplies, blast-furnaces, steel works and shipping ports all nearly side by side, the fact that we had more Colonies needing iron and steel goods than all our contemporaries combined, the fact that we had more money invested in foreign railways and other steel-using enterprises than the next half-dozen nations put together, and the fact that we alone depended hugely upon manufactures to pay for imported food. But before the Great War of 1914 came we were well beaten by Germany, and in several months in the last twelve we have fallen behind Germany (the new and smaller Germany), behind France, and even behind tiny Belgium. Yet our economic position requires a very different status as a nation of exporters. Our recent rate of progress, or retrogression, may be gathered from this little table:—

United Kingdom.—Iron and Steel and Manufactures Thereof in Tons, Exclusive of Engineering Products.

	Exports.	Imports.	Difference.
1907 (our record)	5,152,000 ..	935,000 ..	4,217,000
1925	3,731,000 ..	2,721,000 ..	1,010,000

Please observe that the world's demand has doubled since 1907. Clearly, then, we have not only lost much ground, absolutely and relatively, but we have lost, and are losing, much of our ability to pay for our imports of food. In 1925 the world's output of steel will have been about 88,500,000 tons, compared with 75,000,000 tons in 1913, yet our production has been down by more than 200,000 tons, and our exports by about 1,250,000 tons, including iron with the steel.

In considering the future there are several outstanding points upon which to base our speculations. As badly as we are doing, we are beating the vast United States by 2½ tons to 1 in exports. We are severely pressed by France and Belgium only by reason of the unequal and unfair exchange. When that is moderated we shall certainly be equal to beating back the competition of France, for our neighbour labours under the handicap of long transport distances for her materials to works and products to ports. We are holding up fairly well against German competition in spite of the renewal of the German export bounties. There are now distinctly upward price movements in the American, French, and German steel trades, and this involves reduced competition. Our own iron and steel makers have got their average selling prices down to a level less than 20 per cent. above the pre-war index (18·5 per cent. for November, according to the Board of Trade returns), which is a great testimony to their efficiency. Great economies have been effected during the recent depression. With the Americans enjoying such a home demand that they have little surplus for export, and their costs and prices rising; with the French and Belgians already operating up to the limits of their labour power; with the French carrying increased railway rates as from January 1st; and with higher taxes certain and a moderation of the exchange almost probable, it follows that any increased world orders must be divided mainly between Britain and Germany. And German costs are increasing, whilst credits are more limited than they were awhile back. At home there are prospects of greater steel consumption in house building, by railways, and, before very long, by our shipyards. It seems that the British steel industry is getting over its bad patch.

SIXTY YEARS AGO.

SOME interesting facts and opinions were stated and expressed in an article dealing with recent novelties in marine engineering which appeared in our issue of February 2nd, 1866. The article was based on a paper which had been presented before the Institution of Naval Architects by Mr. R. Murray, a Board of Trade Engineer-Surveyor of lengthly experience. The merits of the surface condenser, then but recently introduced in place of the jet condenser, were first attacked. The bright anticipations expressed with regard to it had not, it was stated, been realised in practice. As a condenser the device was tolerably perfect, but its use created much trouble in the boilers with which it worked and threatened to reduce their life to a short span. The repeated circulation of the water through the boilers and engines led to the water taking up impurities to such an extent as to cause violent priming, while the action of the soft water caused the boiler to corrode rapidly and in a capricious manner. In order to form a protective scale it was customary to use super-salted water containing twice the weight of saline impurities found in ordinary sea water. It was recorded that the engineers of one steamship company were paid a bonus on the coal saved beyond a fixed allowance. They accordingly worked their boilers without a protective scale. By so doing they undoubtedly saved coal, but they ruined the boilers. Surface condensers added, it was stated, about £6 per nominal horse-power to the original cost of the engines, were heavy and complicated, required an increased amount of cleaning and attention, and led to the boilers used with them becoming a great and constant source of anxiety. Compounding in marine engines was also severely dealt with. The additional complication and liability to breakdown of compound engines did not, it was stated by Mr. Murray, carry with it any real economy of fuel. In the P. and O liner Mooltan one of the high-pressure cylinders was placed out of action by a mishap during a voyage. The steam was thereupon passed directly into the large cylinder and there expanded in the usual way. The vessel's speed as a result of the change was in no wise diminished, and on the score of fuel consumption the voyage was the most economical the vessel had ever made. Regarding superheating, Mr. Murray recorded that it was desirable for all vessels making long voyages and with engines working the steam with some fair degree of expansion. Superheaters had, however, been removed from several small vessels making short voyages and working with a small degree of expansion. In all cases it had been found best to limit the steam at the superheater to a temperature of 300 deg. or 320 deg. at the utmost, for a higher temperature was detrimental to the engines. On the question of screw *versus* paddle, Mr. Murray reported facts favouring the paddle as a means of securing regularity of working and comfort in a passenger ship. Indian passengers, it was stated, would sometimes wait months for the chance of a passage by a P. and O. paddle steamer. "The engineers of our modern screw steamers combining all the latest improvements," Mr. Murray remarked in conclusion, "groan under the endless variety of work now thrown upon them and regret the good old times when surface condensers, superheaters, hydraulic apparatus, centrifugal pumps, auxiliary boilers and steam winches were unknown."

AIRCRAFT APPRENTICES.—Five hundred aircraft apprentices between the ages of fifteen and sixteen and a-half (extended in certain cases to seventeen years) are required by the Royal Air Force for entry into the School of Technical Training, Halton, Bucks. They will be enlisted as the result of an open competition and of a limited competition held by the Civil Service Commissioners and the Air Ministry respectively. Successful candidates will be required to complete a period of twelve years' service from the age of eighteen, in addition to the training period. At the age of thirty they may return to civil life or may be allowed to re-engage to complete time for pension. Full information regarding the apprentice scheme, which offers a good opening to well-educated boys of obtaining a three years' apprentice course of a high standard and of following an interesting technical career, can be obtained on application to the Royal Air Force (Apprentice Department), 4, Henrietta-street, W.C. 2.

Linoleum Machinery.

No. III.*

CALENDERING, &c.

IT is scarcely necessary to point out that linoleum comprises a foundation of canvas, backed with paint, on the face of which the cork and cement mixture is fixed, but this account would not be complete without reference to the preparation of the canvas, hessian or burlap, to give it its several names.

The paint backing is, of course, intended to preserve the canvas from rotting, and is applied sometimes before and sometimes after the linoleum is made. A cheap grade of thick paint is used, and is applied by a machine very similar to those used in making oilcloth. A description of the process, peculiar to the linoleum trade, of making the paint will be given later. Two backing machines are illustrated in bolted to a cast iron tube heated by steam. It is usual, during the process of backing, to stitch together the lengths of canvas, as the rolls are used up, so that a continuous length is drawn through into the drying stove.

The linoleum mixture is applied to the canvas foundation by a calendering machine, several examples of which we illustrate. The actual thickness of the material may range from little more than a millimetre to a full quarter of an inch in the case of cork carpet, while a grade of corticene is made even thicker than this, and is subsequently split into very thin sheets to form a packing material in making cheap shoes. The thickness of the coating is, of course, determined by the distance apart of the rolls of the calender, and the demands of the trade are so stringent that the most elaborate precautions are taken to ensure the maintenance of a uniform thickness. The pressure required to compress the mixture between the rolls is quite indeterminate, as all unevenness of the finished surface has to be levelled calender rolls, while for others electric motors are used. The steam engine has the merit that its exhaust can be used for heating the drying stoves; but there is a general tendency towards the adoption of electric driving. It is, however, then necessary to have a variable speed motor, or some change speed gear, as the speed of the calender has to be adjusted within fairly wide limits according to the class of linoleum being made. It will be observed that in the case of the machine illustrated in Fig. 22, a variable speed gear of the Vickers type is adopted. It has the advantage that the speed is infinitely variable between zero and full speed.

In general principle, all calenders are much the same, and the differences are only in minor details, so it will be unnecessary to describe all the machines at full length. They are usually mounted on wheels, running on rails, so that they can be moved from one drying stove to another as each stove is filled with linoleum; but sometimes, as shown in Fig. 21, they are fixed, and then they can only serve one stove,

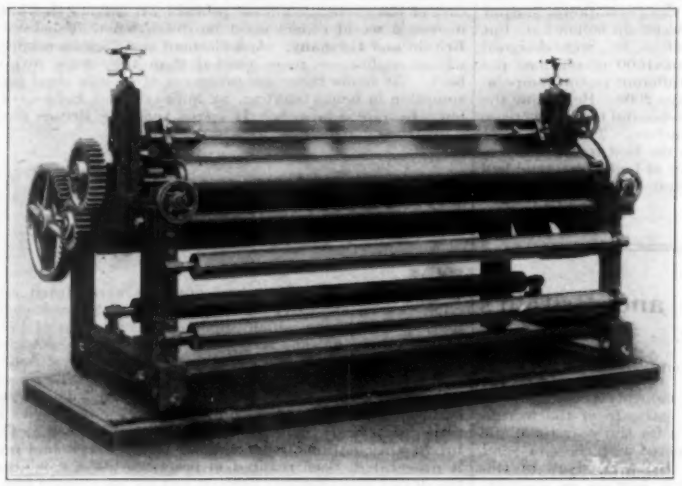

FIG. 18—LINOLEUM BACKING MACHINE—BERTRAMS

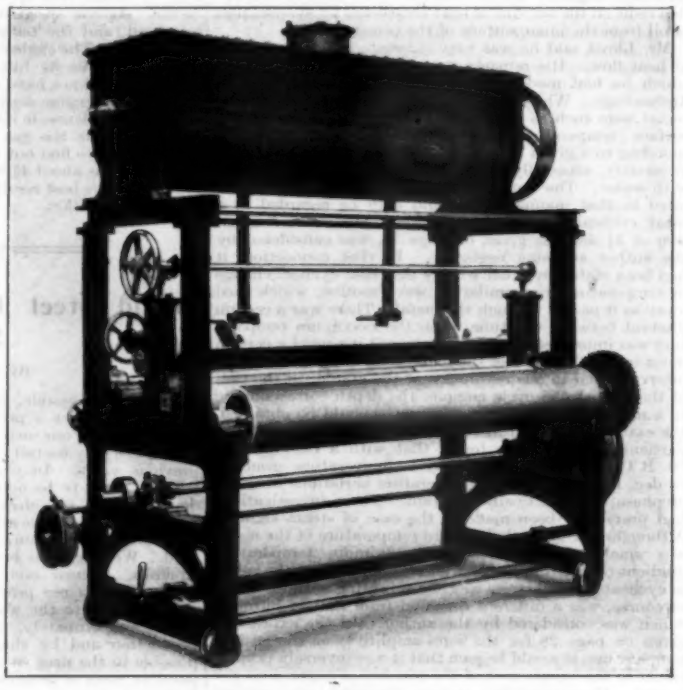

FIG. 19—LINOLEUM BACKING MACHINE—FARMER, NORTON

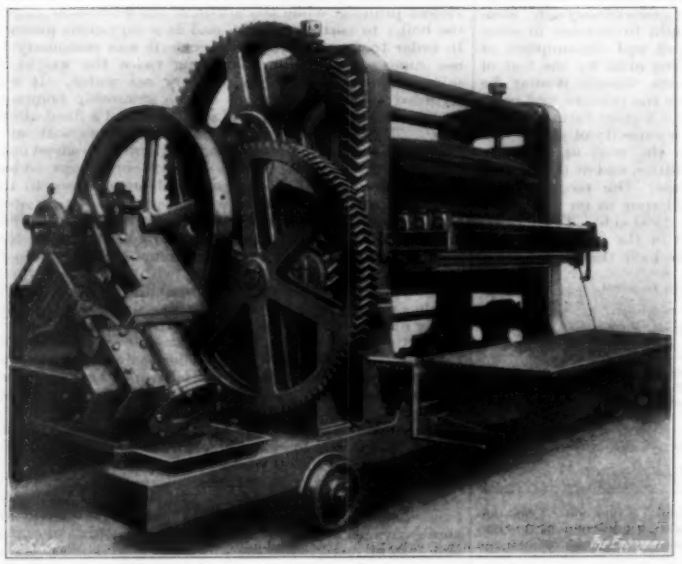

FIG. 20—VERTICAL LINOLEUM CALENDERING MACHINE—FARMER, NORTON

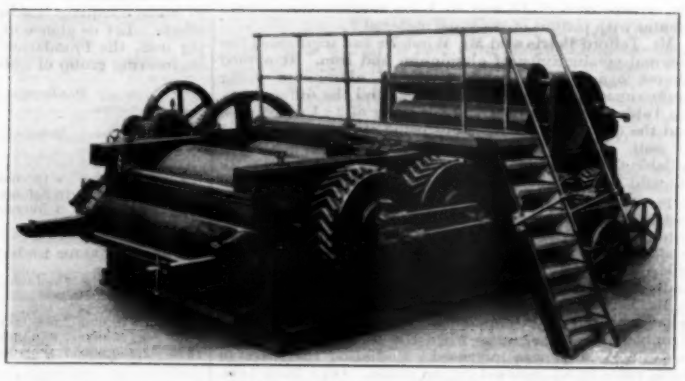

FIG. 21—HORIZONTAL LINOLEUM CALENDERING MACHINE—FARMER, NORTON

Figs. 18 and 19. That shown in Fig. 18 is by Bertrams, of Edinburgh, and comprises two horizontal rolls, round which there is wrapped a heavy rubber band. The bearings of the front roll are adjustable in slides, so that the band can be stretched taut. The roll of canvas is mounted on a stand in front of the machine and is passed over the small rolls shown in the illustration to keep it in tension, and then over the rubber band. The paint is spread on the canvas as it travels through the machine, and is scraped off to an even thickness by a steel doctor knife, which can be set to any height. A fence at either end of the doctor prevents the paint from spilling over the edges of the canvas. The backed canvas is taken away to large drying stoves, where it is hung up in festoons to dry for about twenty-four hours.

Fig. 18 is a back view of a coating machine by Sir J. Farmer, Norton and Co., Ltd., of Salford, and shows the colour pan above. The pan, it may be explained, is provided with a steam jacket to keep the paint fluid, and has a mechanically operated stirrer. The paint flows down two depending pipes and is spread with very little labour over the canvas. In some backing machines the doctor knife is kept warm by being out in the calender regardless of the way the mixture is fed between the rolls; but some idea of the force may be gained from the fact that in setting a machine to make linoleum 1.3 mm. thick, the rolls are set hard against one another. In view of the massive form of the roll housings, which will be appreciated on an inspection of our illustrations, it must require a very large force to separate the rolls and allow the linoleum to pass between them. Incidentally, it is almost futile to attempt to alter the setting of the rolls while the calender is working.

There are two distinct types of calenders, one with the rolls set vertically above one another, which is rather favoured for making corticene, and the other with the rolls arranged horizontally for making linoleum. An example of the former type is illustrated in Fig. 20, which represents a machine by Sir J. Farmer, Norton and Co., Ltd., while Fig. 21 shows a horizontal calender by the same makers. The line drawing—Fig. 22—is a general arrangement of a horizontal calender by the Mellville-Brodie Company, of Kirkcaldy, and the engravings on page 154 represent a very fine machine recently built by Urquhart Lindsay and Robertson Orchar, Ltd., of Dundee.

It will be noticed that in some of the illustrations steam engines are shown as being used to drive the unless the linoleum is first made into a roll for transport.

There are two standard sizes of calenders—for making linoleum either 2 yards or 4 yards wide—but a few machines are built in this country, for the continental trade, to make linoleum 2 m. wide. In any case, the rolls are naturally a little longer than the width of the finished material, and range in diameter up to 36in. The rolls are hollow and provided with connections so that they may be heated or cooled as required. The roll which bears against the canvas backing is of close-grained cast iron, and that which works on the face of the linoleum is of chilled cast iron and has its surface polished like a mirror. It is driven at a slightly higher speed than the other roll, so that there is a slipping action which polishes the surface of the linoleum. The rolls are mounted in a very massive housing, and the bearings are provided with screw gear for setting the thickness of the linoleum. It is noteworthy, in view of the heavy work done by these rolls, that it is found unnecessary to cool the journals, as is the case with a steel rolling mill. They do not, of course, run at any very great speed, some 45 lineal feet per minute being common practice, but the steam heating alone must be a severe tax on the lubrication of the bearings.

* No. II. appeared January 29th.

The canvas is brought to the calender in large rolls and is mounted on a stand in the gangway in front. It is led over a set of stenting rails—as indicated in Fig. 22—to keep it under tension, or over a roll covered with card clothing and fitted with a brake—as shown in Fig. 21. The canvas then goes between the calendering rolls, downwards in the case of a horizontal machine and on to a pair of finishing rolls. The finishing rolls are smaller, but otherwise similar to the calenders. They are driven by belt instead of toothed gearing, as it is essential that the drive should allow a variable amount of slip and a tension device is fitted for this purpose. On leaving the finishing rolls the linoleum is quite hot, so much so as to be unpleasant to touch, and it must be cooled as soon as possible. For this purpose it is led over a water-cooled drum at the back of the machine, which can be plainly seen in both Figs. 21 and the upper view on page 154.

In some factories the mixture is brought to the calender from a central mixing plant and dropped down a shoot to be spread on the canvas by hand; but in others a small roll mixer is mounted above the calender to do the final mixing and distribution. In Fig. 22 it will be noticed a two-roll mixer is adopted, but in the case of the machine which is illustrated on page 154 there is a four-roll mixer. The scratcher cylinder of this mixer delivers the mixture into a hopper which has ends that fit closely to the contour of the calender rolls, and can be adjusted on a bar to determine the width of linoleum made. A magnetic separator is arranged above the hopper to prevent any iron or steel dropping in between the rolls. It is, by the way, remarkable how such things as nails *will* find their way into the machinery, and in the case of one old calender, not fitted with a separator, which we saw, the softer of the calender rolls was marked badly with the impressions of wire nails that had been imbedded in it by the pressure of the hard chilled roll. These marks do not, of course, materially affect the finished surface as they come against the canvas backing of the linoleum.

After passing over the cooling cylinder, the linoleum is led into the drying stove through a narrow slit in the end wall, and is hung up in loops to mature, a process which takes from one to eight weeks, according to the thickness and composition of the material. The temperature of the drying stove is gradually increased from about 110 deg. to 140 deg. as the maturing progresses. The linoleum is hung up by being slung over battens, and as these battens make a scar on the surface, the loops are naturally made as long as possible. In some stoves the battens are as much as 65ft. above the floor, and the stoves are often divided by brick walls into aisles wide enough to take two pieces of linoleum. This arrangement has the advantages of minimising fire risk and allowing one aisle to be filled while the others are at work, as the atmosphere in a closed stove is almost unbearable on account of the fumes gives off by the linoleum, and there must be at least two attendants at the top to put the battens in place. When the linoleum is sufficiently cured, it is made up into big rolls by a simple machine at the back end of the stove and is taken away to be finished.

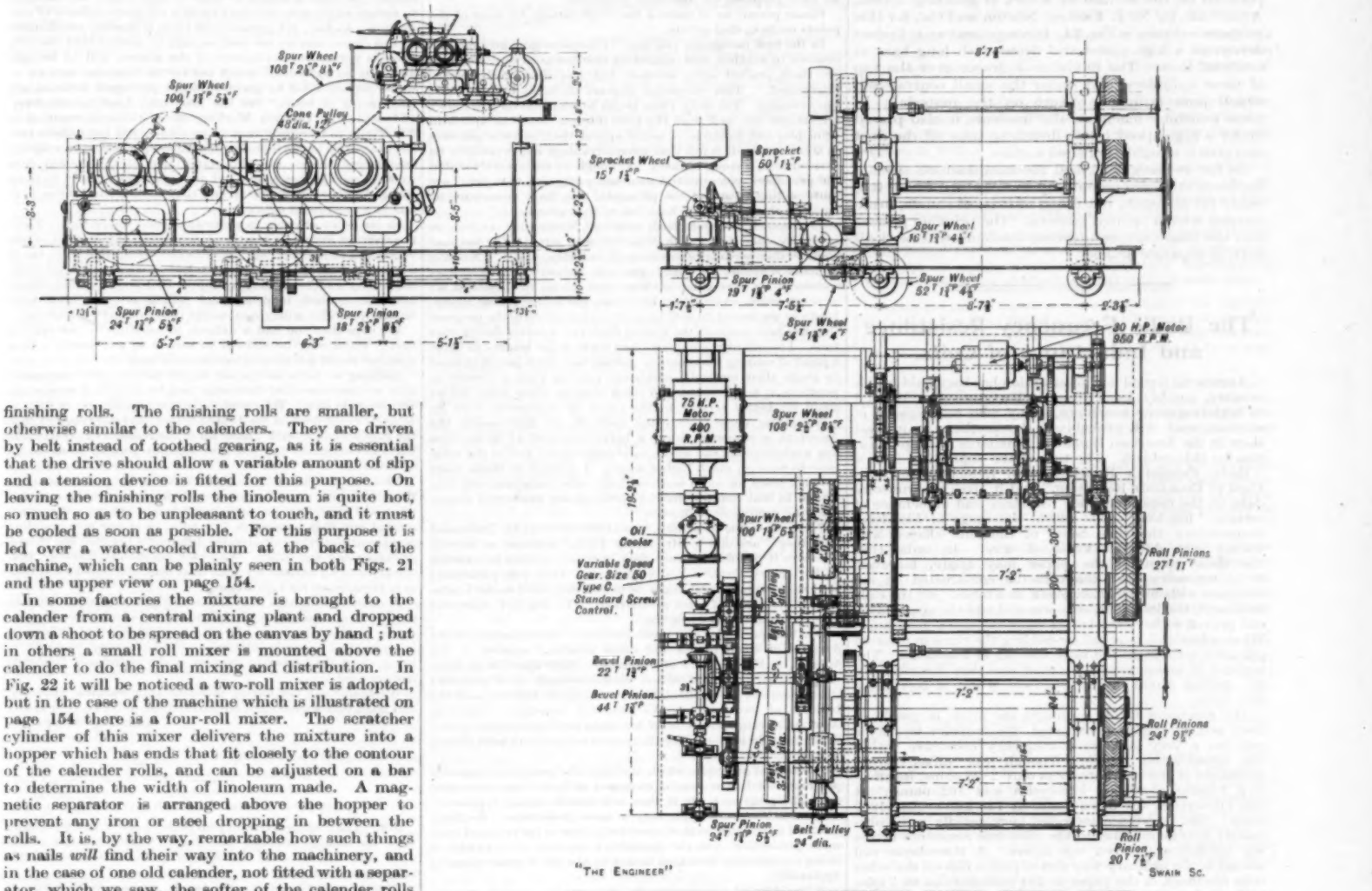

FIG. 22—HORIZONTAL LINOLEUM CALENDERING MACHINE—MELVILLE-BRODIE

During the process of maturing the linoleum grows appreciably, presumably through the absorption of oxygen, and it is desirable that it should not be taken out of the stove until this action has ceased, or there will be a liability for it to buckle up when laid on the floor.

At the Staines works the maturing is carried out on horizontal grids instead of vertically. The linoleum leaving the calender is rolled up with an interleaf of soft paper to prevent the surface being marked by the canvas, and is taken to the curing shed. This shed is very long and is equipped with a great number of shallow grids in a metal framework. The roll of linoleum is mounted on trunnions opposite one of these grids and a batten is fixed to the end. A line from a fast running winch at the opposite end of the shed is then used to haul the whole length off the roll on to the grid. At the same time the paper is rewound on a separate roll for further use.

The linoleum coming from the drying stoves naturally has rather ragged edges, which it is necessary to trim off. The cheap grades and plain material are trimmed in a machine such as that shown in Fig. 23, which comprises two sets of rotary shears. The shearing discs, which can be plainly seen in the illustration, can be set to cut any width and are run at a high speed. The roll of linoleum is mounted on the spindle in the front of the machine, which is provided with a brake to keep the material in tension, and is rewound on another spindle on the opposite side. The drive to this spindle is taken through a slipping clutch to accommodate the increasing size of the roll. The machine shown in Fig. 23 is by Bertrams.

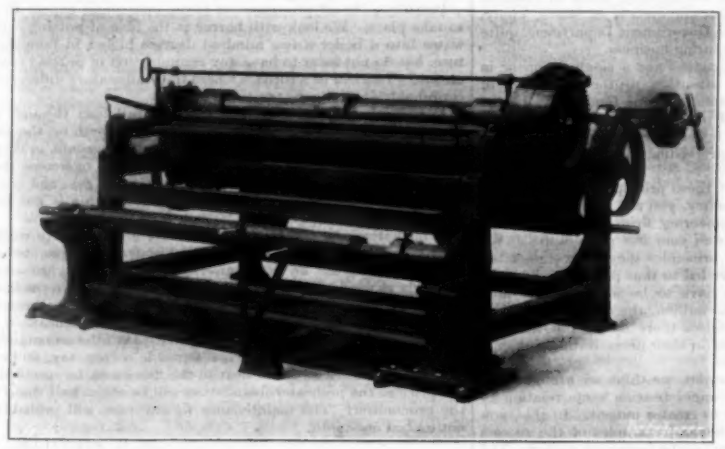

FIG. 23—LINOLEUM EDGE-TRIMMING MACHINE—BERTRAMS

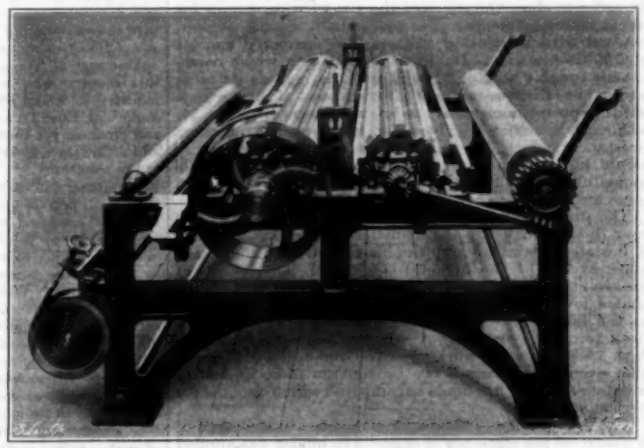

FIG. 24—LINOLEUM POLISHING MACHINE—FARMER, NORTON

One of the objections to machine trimming is the speed at which it is carried out, which prevents any possibility of inspecting the material for defects.

Linoleum which is to be printed is not trimmed until the printing is finished, and then the better qualities are trimmed by hand, as this gives an opportunity for inspecting the material and allows the trimming to be adapted to the pattern. The piece of linoleum is laid out on a long wooden table with a

groove cut down its length near one edge. The man uses a knife for trimming, and the groove is to clear its point. He has a straight-edge with a sharp spike at one end and a little depending fence at the other. This fence bears against the already cut edge and keeps the back end of the straight edge in line, while the spike steadies the front end when it has been set to conform to the pattern.

Some of the superior qualities of linoleum are polished on the surface by a sort of grinding action. A machine, by Sir J. Farmer, Norton and Co., for this purpose is shown in Fig. 24. It comprises two cylinders driven at a high speed and fitted with long bars of artificial lava. The linoleum is drawn over the top of these cylinders, and under the small central roll, which puts a light pressure on the material. In some polishing machines the linoleum is also passed under a high-speed rotary brush to take off the dust and give it a highly polished surface.

So far we have described the manufacture of plain linoleum or corticene only up to the stage where it is ready for dispatch, but much of it is, of course, ornamented with a printed pattern. The printing process and the manufacture of inlaid linoleum will be dealt with in separate articles.

The Radio Frequency Resistance and Inductance of Coils.

ALTHOUGH a good deal of attention has been paid in this country, notably by Professors Fortescue and Mallet,* to high-frequency resistance, many who are engaged in wireless work will probably find something to interest them in the American Bureau of Standards latest publication on this subject. The title of the paper (No. 298) is "Radio Frequency Resistance and Inductance of Coils Used in Broadcast Reception," and it gives experimental data on the radio-frequency resistance and inductance of certain "low-loss" coils within the range of broadcast frequencies; the coils being of different shapes and wound with different kinds of wire. In order that the data given in the paper may apply, however, it is necessary that the coils be constructed in accordance with information given in a table. Of the coils measured, the loose basket weave coil and the single-layer coil proved to have the lowest radio-frequency resistance. When a binder is required for holding the turns in position collodion introduces the least amount of resistance. The method of measurement adopted was that described by Mr. August Hund in the *Electrical World* of November 8th, 1924.

The results of the experiments are given in graphical form and, as might be expected, the ordinary two-layer coil has a very large radio-frequency resistance within the broadcasting range. Though the direct-current resistance of the coil tested was only 2·75 ohms, its effective resistance at 500 kilo-cycles was 162 ohms; at 580 kilo-cycles, 465 ohms; and at 748 kilo-cycles, 1800 ohms. The resistance increases very rapidly until ultimately it is mainly due to the dielectric resistance across the insulation between the layers. A three-layer coil wound in the ordinary way and adjusted like all the other coils discussed in the paper to 291 microhenries at 1 kilo-cycle, had a radio frequency resistance of several thousand ohms at a frequency as low as 400 kilo-cycles. The loose basket weave and single-layer coils have, as we have already said, low values. Next comes the radial basket weave coil, with a hard rubber core, while the four-layer bank wound, three-layer bank wound, and the honeycomb coils show considerable percentage increases.

Curves are given showing the ratio of $\frac{L}{R}$, which is always smaller than the ratio $\frac{L_0}{R_0}$ at 1 kilo-cycle. Since the apparent inductance and the radio-frequency resistance increase with frequency, this ratio in certain cases has only small changes, although L and R are changing rapidly. In order to show the effect of the size of wire, curves for the resistance for Nos. 28, 24, and 16 double cotton-covered wire are plotted and are also compared against No. 32–38 litz wire. In all cases the latter, which corresponds roughly to No. 32 solid wire, as regards its cross section, has the lowest effective resistance. If solid wire is used it appears unnecessary to use wire larger than No. 24, although No. 16 wire gives, for the lower frequencies, resistances which are slightly lower. The latter wire would, however, make the winding of certain types of coils more difficult and the size of the finished coil would be too large for convenient use in receiving sets.

The practice of spacing the turns of a single-layer coil by a distance equal to the diameter of the wire does not, it is stated, make any appreciable reduction in the resistance, except at the higher frequencies. The effect of broken strands in litz wire is considered, and it is shown that a few broken strands do not have a serious effect, as the radio-frequency current apparently finds its way back across the strands. A table in the paper relates to Nos. 32–38 litz wires working at 750 kilo-cycles and shows that even if six strands are broken the radio-frequency resistance is only 3·4 ohms as compared with 3·1 ohms for perfect strands.

The final section of the paper is devoted to the effect of a binder on the efficiency of coils. The binder was applied in each case to a single-layer coil, and just sufficient of the material was used to cover the entire surface, and in every case the coils were thoroughly dried. All the materials used caused a very slight increase in the resistance of the coils. Collodion seemed to give the best results, and it has the inherent advantage of drying rapidly after application. The authors of the paper are Messrs. August Hund and H. B. De Groot.

AN oil refinery is to be put up at Khanagin, Persia, by the Anglo-Persian Coil Company.

* See THE ENGINEER, January 16th and March 6th, 1925.

Letters to the Editor.

(We do not hold ourselves responsible for the opinions of our correspondents.)

ENGINEERING IN AMERICA AND GREAT BRITAIN.

SIR,—You were kind enough in your last week's issue to make exhaustive comment in your leading article on the memorandum we have prepared on American prosperity.

Please permit us to make a few observations on some of the points made in that article.

In the first paragraph you say, "Observers may go from one country to another, and, admitting the merits of one, desire to see them grafted upon another, but this desire will remain ungratified." This statement appears to us to be altogether too sweeping. The daily Press began to comment on this report a fortnight ago, and from the keen interest shown in American principles and methods, it would appear that, in some quarters in this country, it is felt that some advantage might possibly be derived from a study of them. Although we have merely stated the principles, you admit in your last paragraph that you "are quite willing to accept the principles they have enunciated as amongst the causes that have led to that prosperity."

In a speech at Sunderland, only last Wednesday, no less an authority than the Prime Minister, who admittedly has had considerable personal experience of industry, said: "Nothing remains constant for many years in industry. I sometimes wonder if we have gone to sleep, some of us, in these last six or seven years, while others have been particularly wide awake. I believe we should do well to study and to emulate the progress that has been made in the United States of America during that time. I would urge employers and trade union leaders to make a point of visiting that country quickly and often just at present to study their methods, which are proving such a success in production, and I venture to think that no trade union leader could do better service to the cause he represents than by investigating closely what the methods are that enable the American workmen to enjoy a better standard of living than any workpeople in the world, to produce more, and at the same time to have so much higher wages. I venture to think there is much more for us to learn on both sides from studying conditions in that country than by spending any amount of money studying conditions in Moscow."

Speaking of the principles, you attribute to us the statement that they "are due to Mr. Henry Ford," whereas we merely "believe it possible to trace their original *adoption* in America to Mr. Henry Ford." You continue: "They (the principles) are nine in number and might be briefly described as the fundamental principles of mass production." To this last statement we must take strong exception.

Our first principle, which you consider "an expression of the doctrine of small profits and quick returns," applies, in our opinion, to the majority of businesses—quite apart from those which adopt mass production methods—such as department stores, bespoke shoemakers, house building contractors, and the builders of locomotives. We visited a locomotive works in America having a capacity of ten main line locomotives a day, which are sold in the British Empire in competition with British makes.

Our second principle, which says that the productive capacity *per capita* of labour can be increased without limit depending upon the progress made in time and trouble-saving appliances, we contend does not apply only to mass production. We think you will agree with us that a painter's trade is far removed from mass production, yet the productive capacity of a painter is being considerably increased to-day by the use of paint-spraying appliances.

"Rapidity of turnover makes for smaller capital requirements"—our third point—can obviously be applied to a business of any description. An American laundry handles in eight hours what an average English laundry of the same size takes six days to do.

Our fourth principle, advocating the reward of labour by wages bearing some relation to output, can be applied without question in many spheres of employment, quite apart from concerns engaged in mass production. A stockbroker's clerk who can handle a greater amount of work by using a calculating or ledger-posting machine earns and should be paid higher wages.

The remaining principles (Nos. 5 to 9), which touch on the importance of welfare, free exchange of ideas between competing firms, promotion by merit and ability only, value of research and experimental work and the elimination of waste, apply, with the exception of No. 6, to a Government Department quite as much as to a motor manufacturing business.

You say: "There is, we imagine, not a single engineer in this country who has given attention to the economics of industry to whom these principles are not familiar." In the same way Euclid's axioms and postulates are equally familiar and obvious, yet Euclid found it necessary to write them down and define them clearly before proceeding with the development of the science.

Admitting the correctness of these principles and that they are not all practised in this country, you ask us whether or not they are practised by all engineering firms in America. In reply to this we would quote from your last paragraph: "We are quite willing to accept the principles they have enunciated as amongst the causes that have led to that prosperity."

You state: "When things have to be made by the unit instead of manufactured by the million, the conditions change completely." Whatever differences there may be in the conditions we fail to see any reasons for their necessitating a change in the principles of management.

With regard to wages and output, we think we are on fairly safe ground in assuming that wages bearing some relation to output constitute an incentive to greater output. In this, you "believe we are mistaken." Several examples of the success of such a policy in this country can be instanced to-day. The fact that you say "It must be accepted as a common experience that piecework is not popular in British engineering works" is an entirely different matter. While the chopping and changing of piecework rates may not be popular with the workers in this or any other country, it does not follow that wages bearing some relation to output is equally unpopular. You argue that "the lure of money is not so effective with British mechanics as it is with that heterogeneous class which follows the same calling in America." We beg to point out that the ultimate object of all engaged in industry is the creation of wealth, for masters and men alike, and we venture to suggest that the failure of management in certain industries to offer "the lure of money" is the root cause of the present dominating strength of "trades unionism in this country."

With regard to your statement that "the question as to what wages men should be allowed to earn is an extremely complex one," we should like to know if there is anyone of sufficient status in the world to arrogate to himself the authority to dictate or even to consider what wages any man should be *allowed* to earn.

It is your opinion that "however much the cost per piece may be lowered by quick output for high wages, it would be still less with quick output and lower wages." Such a condition is, we venture to say, a psychological impossibility, since, once high output has been attained because of high wages, any attempt to reduce wages will obviously cause a complete collapse of production. In fact, the present coal crisis is directly attributable to this cause, and we are bold enough to predict that the only possible permanent settlement of the dispute will be brought about by an agreement which has for its basis the increase of wages accompanied by greater output *per capita* without any lengthening of hours. On the 22nd ult., Lord Londonderry, addressing the Dawdon Working Men's Club, is reported in *The Times* to have said that many owners did not believe that the prosperity of the industry depended upon reducing wages or lengthening hours. He also stated that at the present time America paid higher wages and gave reasonable hours to those engaged in the coal industry and that the industry throughout was in a prosperous condition.

So far as we are able to understand your query that "There is surely an economic relationship between the amount of the wages and the selling cost," we can only reply that in so far as our own knowledge of economics takes us, we have not yet come across any such law. May we repeat that wages should always have an upward tendency and selling prices a downward tendency? The selling cost would then gradually disappear.

We note that you find it difficult to subscribe to our opinion that "wages may be allowed to ascend to any level." How then, we would ask, do you feel about salaries?*

Nothing we have said in our report justifies your statement that we have assumed that what can be done in America can also be done here. We merely give our experiences of what is actually being done in the United States, and only suggest that the Englishman should "wake up to the realities of present-day business conditions and practice, and put his own house on an economic footing."

You attribute to us "the error of taking for granted that the British workman and the American workman are alike and that what will appeal to one will appeal to the other." We would remind you that paragraph 4 on page 18 of our memorandum points out the very considerable differences between the British workman and any other. We would emphasise, however, that workmen of all nations are alike in at least one respect and that is in their desire for high wages.

It must be admitted that the lack of good relations between employers and men have precipated several of our trade disputes during the last few years. In order to introduce "the new spirt in industry," some constructive work is surely required to bring about the necessary changes in the attitude of industrial management.

We thank you for having given us your valuable criticism, and trust that we have not encroached too much on your space.

BERTRAM AUSTIN,
W. FRANCIS LLOYD.

London, S.W. 3, February 1st.

* Exactly the same.—ED. THE E.

THE FUTURE OF THE ECONOMISER.

SIR,—The leading article in your recent issue of THE ENGINEER is of the utmost interest. Mr. George Tansley's letter of the 15th inst. makes some statements in connection with this subject to which I beg leave to take exception.

Maintenance Charge for Brickwork, Arches, Grates, &c.—If the long arch which is necessary for the thorough ignition of fuel when fed with cold air be maintained when hot air is used, the probability is that the arch will burn and the grate deteriorate. The use of preheated air ensures extremely rapid ignition, and this long arch can be replaced by a short one, leaving practically the whole of the fuel bed exposed to the heating surface of the boiler proper. When the fuel is burned in this way the radiation from its surface being unrestricted, there is no overheating of the grate nor of the arch, for the heat transfer to the cool boiler surface is very rapid indeed.

In a recent case it has been possible to compare two boilers side by side, the one operating with cold air, the other with highly preheated air. The brickwork in the cold air fed boiler depreciated, if anything, more rapidly than in the other.

Putting aside all preconceived ideas, one would expect this to take place. We look with horror at the idea of putting cold water into a boiler a few hundred degrees higher in temperature, but do not seem to have any compunction in putting cold air into a fuel bed or a furnace where the temperature difference is probably from five to ten times as great.

Fan Power.—The normal resistance at full load through a Howden-Ljungstrom air preheater is ½in. w.g., both on the air side and the gas side. The fan power on this account is very small indeed. As a rule, the fans are designed to overcome the whole of the resistances due to the grates, flues, &c., and consequently the power may be fairly large, but this is not on account of the preheater itself.

If bled steam be objected to, it is more economical to work with a preheater and to heat the feed water with live steam rather than to use an economiser which will rarely recover regularly as much as 30 per cent. of the available heat in the flue gas. The same gases passed through a good air preheater would render useful over 60 per cent. of their available heat.

It is interesting to glance at the relative cost of the economiser and preheater installation. If a reasonable saving, say, 60 per cent. of the otherwise waste heat in the flue gases, be specified, the price of the preheater installation will be about half that of the economiser. The maintenance in any case will probably not exceed one-tenth.

A. L. MIEVILLE.

Glasgow, W. 2, January 29th.

INSTITUTION OF NAVAL ARCHITECTS.—The annual meetings of the Institution of Naval Architects will take place on Wednesday, March 24th, and the two following days, in the Lecture Hall of the Royal Society of Arts, John-street, Adelphi, W.C. 2. His Grace the Duke of Northumberland, President, will occupy the chair. The annual dinner will be held on Wednesday, March 24th, at 7.30 p.m., in the Grand Hall, Connaught Rooms, Great Queen-street, Kingsway, W.C.

Railway Matters.

THE New Zealand Government Railways have christened a locomotive Passchendaele as a memorial to those of its servants who fell in the war. The engine is the first of the "Ab" class, 4–6–2 type, to be built in the Dominion.

CONSIDERABLE alterations are in progress at Millbrook on the Southern Railway, towards the reconstruction and enlargement of that station, which is outside Southampton. Four new sidings have been completed, which accommodate 120 trucks, with ample cart-road provision for each road.

FOR a year or more the southern end of Tottenham Court-road has been obstructed by works in connection with the new station that will serve the Central London and Hampstead tube railways at that point. The early completion of that work is now forecast by the opening, on Monday last, of two of the new escalators.

THE various local authorities interested in a proposed extension of tube railways in South and South-West London met in conference last Wednesday week. The routes discussed were for a central line down the Brighton-road from Kennington to Croydon, with one branch from Croydon to Penge and Dulwich and on to the Elephant, and another branch from Croydon to Morden. It was eventually decided to concentrate the efforts on a railway from Kennington along the Brixton-road, through Brixton-hill, Streatham-hill, and Streatham High-street to Norbury. A deputation is to wait upon Lord Ashfield.

AT a meeting of the Southampton Harbour Board on the 28th ultimo Mr. Gilbert Szlumper, the assistant general manager of the Southern Railway—who is also the manager of that company's docks and steamers—said, in reference to plans then before the board for the construction by the railway company of some new docks, that the directors had approved the plans and work would shortly be begun. There would, however, be a delay of a month or so, as an important change was contemplated. The company had determined to increase the quayage from 10,000ft. to 15,000ft. That sounded ambitious, but the company did not think it was unduly optimistic.

ACCORDING to the Board of Trade returns, the value of the railway material exported during the first ten months of last year was as follows, the corresponding figures for 1924 and 1923 being added in brackets:—Locomotives, £2,246,936 (£1,597,681, £2,371,255); rails, £1,614,682 (£1,382,674, £2,068,568); carriages, £1,253,056 (£962,108, £834,389); wagons, £2,978,399 (£2,839,188, £2,622,310); wheels and axles, £498,693 (£493,178, £811,720); tires and axles, £369,410 (£511,836, £536,876); chairs and metal sleepers, £842,715 (£1,042,222, £799,973); miscellaneous permanent way material, £1,189,943 (£947,812, £979,837); total permanent way material, £4,684,404 (£4,562,403, £5,450,467). The weight of the rails exported was 172,989 tons (149,468 tons, 230,619 tons), and of the chairs and metal sleepers 76,259 tons (83,402 tons, 69,618 tons). During the month of October last locomotives of the values named were shipped to the following countries:—India, £27,000; Argentine, £12,235; South Africa, £1000; and Ceylon, £764. The rails shipped included the following:—The Argentine, £36,017; South Africa, £34,121; India, £29,662; New Zealand, £4534; Australia, £862; and British West Africa, £467.

AT the rear of the last vehicle of every passenger train is a lamp, usually painted red, which is known as the tail lamp. At the rear of the last vehicle of every goods train are three lamps, two of which are on the side and are known as the side lights; the third is the tail light. Taking the side lights first, they are to indicate to the driver that the whole of his train is following the engine; the absence of the side lights would indicate that the train was incomplete—possibly a coupling had failed and the rear part been left behind. Passenger trains do not carry side lights now, as, being equipped with automatic brakes, an accidental separation would cause the brakes to be applied on all the wheels of the train and both portions automatically would pull up. The Great Western, however, still retains the side lights on its passenger trains. The tail lamp is there for the guidance of signalmen to tell them that the passing train is complete. The block telegraph rules are very strict as to that, and should a train pass without a tail lamp a signal is sent forward to stop the train and another signal is sent to the rear to hold up all trains until the matter is cleared up. Trains that carry slip carriages have the usual tail lamp on the main portion of the train and a special one on the rear of the slip portion. We are led to refer to this subject because of the action of a signalman who missed the tail lamp from a goods train. Inquiries showed that a wagon had been derailed and the line in the rear of the signal-box had been fouled.

WRITING in *The Times* of January 22nd, a letter full of biting sarcasm as to the alleged iniquities of the Southern Railway, as revealed by his experiences when returning to London from the Riviera on the 14th-15th, Sir Ellis Hume-Williams provided Sir Herbert Walker with an unexpectedly excellent opening for getting in a good word for the Southern Railway. The engine working the boat train from Paris failed, and the train arrived at Calais 1 hour 12 minutes late. Owing to the bad weather the train from Switzerland, which should have connected with an earlier boat from Boulogne, missed it and had to be sent on to Calais. In consequence 257 additional passengers had to be provided for. The Swiss train connecting with the Calais boat was, further, 31 minutes late, and the net result was some congestion and consequent discomfort, which was added to by the arrival of the boat on the 11 a.m. from London service which, it should be noted, was punctual. The complaints of Sir Ellis as to discomfort on the boat were answered by the statement that the Empress belongs to the Northern of France and not to the Southern. Owing to fog the vessel was an extra 12 minutes in crossing, but no time was lost in the station duties at Dover, which fact, "despite the abnormal number of passengers arriving, proves that the modernised arrangements now in force there are not so 'imbecile' as Sir Ellis Hume-Williams would have the public believe." Being 1 hour 40 minutes late the express lost its train path to Victoria and was delayed 12 minutes in its journey.

Notes and Memoranda.

IN summarising a paper on tube mill grinding, read before the Institution of Chemical Engineers, Dr. G. Martin said that:—(1) A method of accurately determining the surface of sand had been devised; (2) the work required in grinding sand was proportional to the surface produced up to at least a fivefold increase of surface; (3) the effect of dust in cushioning the blow was small in the tube mill; (4) grinding in a current of air in the tube mill did not affect a noticeable saving in power.

IN the course of a recent lecture at St. Bartholomew's Hospital, Sir R. A. Jones remarked that coal dust appeared to be absolutely harmless. The phthisis rate among miners was the lowest in any employment. The change from the cold upper crust to the lower warm air affected the miner more than the particles of dust, and although the miner's lungs were black inside, yet compared with other workers who were exposed to dust they were remarkably free from tuberculosis.

IN the course of a paper read before the Institution of Structural Engineers, Major R. A. B. Smith said that the impact of vehicle wheels on the road surface might be as high as seven times the static load on one rear wheel when a solid tired truck struck a 1in. obstruction at 16 miles per hour, an average value being about four times. For pneumatic tires the maximum impact value was probably not more than 1¾ times the load at one rear wheel, and an average value was not more than 1¼ times the load.

COMMENTING on the accidental explosion of a blasting charge, in a coal pit, through the drilling of an adjacent hole, Mr. J. S. Hayes suggested, at a recent meeting of the Yorkshire Branch of the National Association of Colliery Managers, that "although reliable opinion has been expressed that the drill must have actually struck the charge in this case, I am inclined to think that a modern power drill, delivering 300 to 400 strokes per minute, with a blow of 300 foot-pounds, is capable of transmitting sufficient concussion through hard rock and a well-stemmed hole to explode a detonator without direct contact."

IN the course of an address given to the Walsall Rotary Club, Mr. J. Pickin remarked that it had been stated that the use of pulverised coal really substituted one nuisance for another, in that large quantities of fine dust were emitted from the stack, and that should pulverised coal firing be generally adopted, that emission of dust would become as injurious as the black smoke of the present day. Really, he said, it was doubtful if, in a properly designed pulverised coal plant, the quantity of dust discharged from the stack was greater than that discharged from the chimney of a hand or mechanical stoker fired furnace. The former was more noticeable because it was the only visible matter that was emitted from the stack, whereas the grit from a stoker fired furnace was not seen because of the smoke.

SUMMING up a consideration of earthquake expectancy in California, in the *Engineering News-Record*, Mr. H. D. Dewell says that the hypothesis of accumulating pressure between blocks of the earth's crust along fault planes until the stresses reach the slipping resistance of the blocks, or the "elastic rebound theory," fits in with (1) the historical record of tectonic earthquakes; (2) the measured movement of established points on the earth's crust; and (3) the evidence of internal stress in the rock masses. Going further, the hypothesis and evidence point to the belief that the stresses were dissipated in 1906 in the northern district to such an extent that a major shock along this portion of the San Andreas fault may reasonably be expected to be deferred for from twenty to thirty years from now.

RECENT investigations at Birmingham University have, according to the *Chemical Trade Journal*, indicated yet another way in which the chemist might help in the reduction of the element of risk always present in coal-mining operations. The spontaneous combustion of coal underground has only too frequently led to disastrous fires, but long before any localised incipient combustion occasions a temperature rise capable of detection by the usual methods, modifications are caused in the composition of the return air, which give tangible and unmistakable evidence to the analyst. The principal modification is the progressive increase in the proportion which the carbon-monoxide content of the return air bears to its carbon-dioxide content, while at the same time the percentage of carbon-dioxide in the return air progressively decreases.

SINCE the war it has, according to the *South African Mining and Engineering Journal*, been the practice of the Durban Town Council to concede a preference, and at times a substantial one, to British material, particularly as regards engineering supplies. It is evident that an attempt is to be made to upset this very patriotic attitude, for at a recent meeting of the Council the chairman of the Electricity Committee questioned the advisability of continuing on present lines. The Mayor, however, ruled the matter out of order, and stated that it must be brought up as a motion. Further developments will be watched with interest, but it is noteworthy that in electricity supply Durban has made exemplary progress and offers remarkably cheap rates for industrial and domestic consumption. It would therefore seem that the public has not been in any way penalised by patriotism.

DESCRIBING the explosion of an oxygen cylinder, which had contained sea water, *Industrial Gases* says that the internal corrosion was not only exceptionally severe, but unusual in character, the oxide formed being thick in proportion to the metal actually eroded, and somewhat porous and soft towards the outer surface. Thus it may fairly be assumed that, even when all traces of water had apparently been drawn off in the oxygen factory before the cylinder was refilled, sufficient sea water was retained in the iron oxide for the corroding effect to continue, especially in the presence of compressed oxygen. Ordinarily, as is already well-known, the oxidation of iron in a charged oxygen cylinder is very slight, even in the presence of water. The chemical compounds in sea water, however, lead to quite different results, as they act catalytically to accelerate the combination of iron and oxygen, and this action was undoubtedly reponsible for the condition of the ruptured cylinder.

Miscellanea.

THE fourteenth International Geological Congress will be held in Madrid, Spain, in May and June of 1926.

A SCHEME for the provision of a beet sugar factory for Carmarthenshire, Pembrokeshire, and Cardiganshire is under consideration.

CANADA is now the world's largest producer of nickel. The present output is about 35,000 short tons—2000 lb.—or 80 per cent. of the world's requirements of the metal.

THE dust collectors, thirty-three in number, which the Birmingham Corporation is installing at the new power-house are being supplied by the Davidson Company, of Belfast.

GOVERNMENT statistics are to be prepared regarding the production of motor cars in Germany. The first particulars will probably refer to the production of motor cars and engines in 1925.

THE Aberdeen Harbour Board has decided to order a new suction hopper dredger from Simons and Co., of Renfrew. It is to be capable of raising 1000 tons an hour from a depth of 32ft. and 850 tons from 42ft.

IT is noteworthy in connection with the launch of H.M.S. Ambuscade, the first destroyer of the new programme, that she is equipped with high-pressure superheating Yarrow boilers, one of which is fitted with air preheaters.

ASBESTOS nearly equal in quality to that of the deposits at Quebec has been found at the head waters of Quoicek Creek, near Lytton, British Columbia. The vein has been traced for several miles, and has been found to be of considerable width.

AN investigation conducted by electrical firms into accidents which have arisen from the use of gas, petroleum and electricity in Germany shows that out of a total of 800 accidents, 301 occurred with gas, 380 with petroleum, and only 138 with electricity.

ACCIDENTS in mines producing metals and non-metallic minerals (except fuels) in the United States in the calendar year 1924 resulted in 418 deaths and 33,118 non-fatal accidents, which disabled an employee beyond the day on which the accident occurred.

HIS Majesty the King has consented to become patron of the annual general meeting of the Society of Chemical Industry to be held in London during the week commencing on July 19th. The third Messel Memorial Lecture will be delivered by Lord Balfour at the Mansion House on the afternoon of the first day of the meeting.

IT is proposed to erect at Newport, South Wales, a new type of coal shipping conveyor, alongside the present No. 20 hoist at that port. The main conveying belt, of steel, will be 4ft. wide and run at a speed of 625ft. per minute. One of the outstanding characteristics of the plant will be the reduction of breakage of the coal through impact in pulling from one level to another.

THE output of gold, silver, copper, lead, and zinc from Colorado ores in 1925 in terms of recovered and estimated recoverable metal was 7,205,000 dollars in gold, 4,380,000 ounces of silver, 2,500,000 pounds of copper, 63,000,000 pounds of lead, and 61,000,000 pounds of zinc, according to Chas. W. Henderson. The corresponding outputs for New Mexico were 552,000 dollars in gold, 790,000 ounces of silver, 75,626,000 pounds of copper, 7,000,000 pounds of lead, and 17,700,000 pounds of zinc.

THE War Office, it is stated, has applied for a supply of electricity to Stirling Castle. The matter has been considered by the Corporation's Electricity Committee, to which the burgh electrical engineer reported that to give this supply a feeder cable would require to be laid at a total cost, including pillars and jointing, of approximately £980. The probable revenue to be derived would be from £270 to £300. The War Office proposes to instal a large electric cooker. The electrical engineer was authorised to negotiate with the War Office regarding the matter.

NOTWITHSTANDING the world-wide depression, Britain's proportionate share of the world's trade in engineering products is to-day as high as it ever has been, and the British Engineers' Association reports an encouraging increase in the flow of inquiries and orders to this country. It is interesting to note, in this connection, that whereas in 1913, only 34 per cent. of the total exports of machinery from this country went to British Possessions, the figure for 1924 was 49·9 per cent. There is every reason to believe that, with the growth of trade within the Empire and the economic recovery of foreign markets, British engineering industry will secure an even larger share of the world's trade than it has hitherto enjoyed.

H.M. TRADE COMMISSIONER at Toronto states that in Ontario the total installation for 1925 was about 200,000 horse-power, for which the Ontario Hydro-Electric Commission was largely responsible. The Commission's Queenston-Chippawa plant was brought to its complete capacity by the addition of two 55,000 horse-power units, while the largest of its other activities was the completion of the 75,000 horse-power plant at Cameron Falls, on the Nepegon River. Other developments include the 24,000 horse-power extension to the Island Falls plant on the Abitibi River by the Abitibi Power and Paper Company, and the 17,000 horse-power development of the Keewatin Power Company at the western outlet of the Lake of the Woods.

THE New Zealand Sounds Nitrates Syndicate, which is composed of New Zealand business men, has been granted a sixty years' licence by the New Zealand Government to generate at Smith's Sound a force of 300,000 continuous horse-power, a sixth of which must be in operation within seven years, while the construction of works to generate the balance must be begun within ten years. The Government retains the right to resume possession with compensation at the end of thirty years. The power produced is to be used for electro-chemical, metallurgical and other purposes. The rental payable to the Government is, it is stated, to be 1s. per annum per kilowatt. Although the price to consumers for lighting purposes is restricted to a penny a unit, that is merely a formal provision, as the territory is uninhabited.

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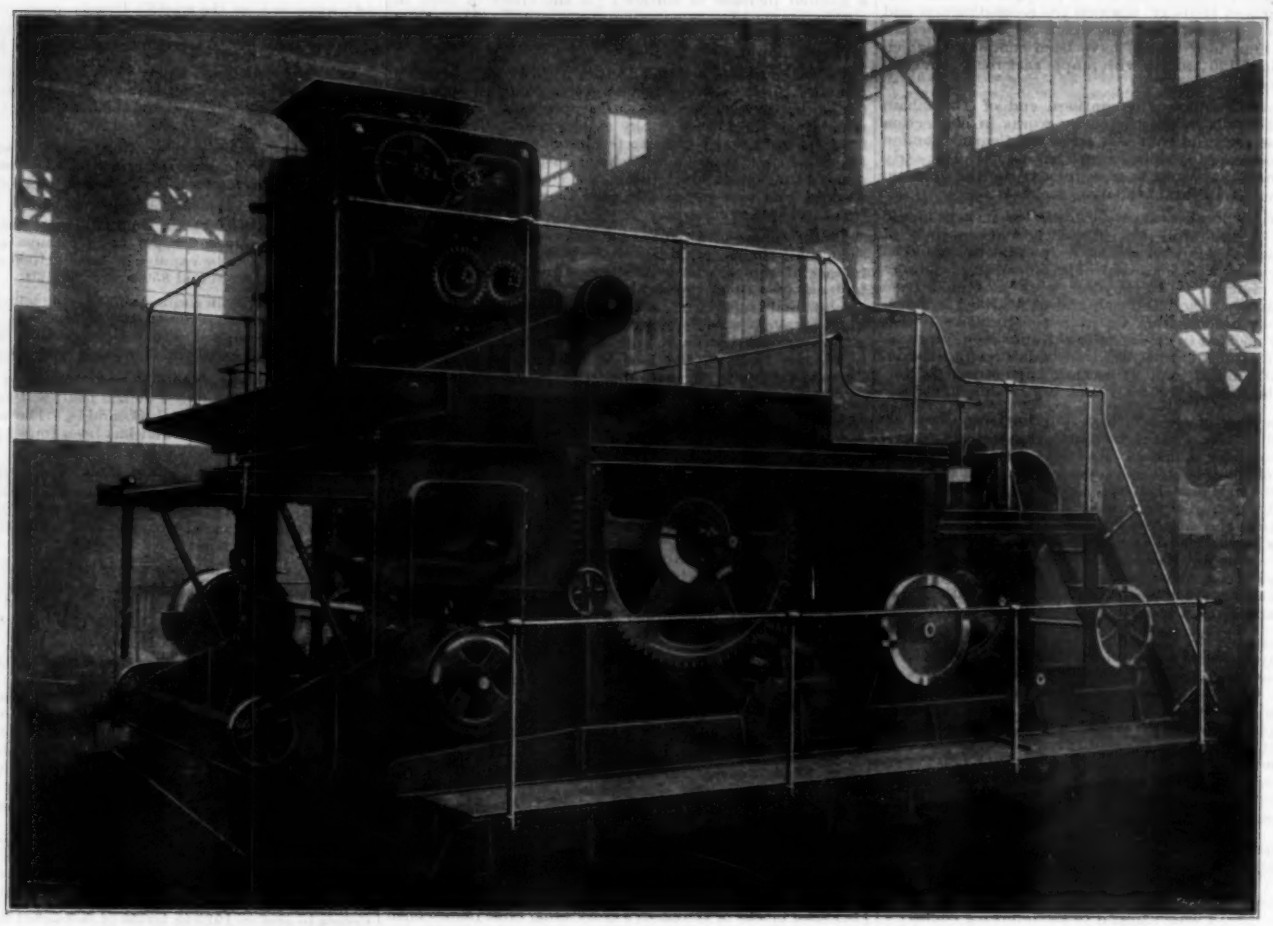

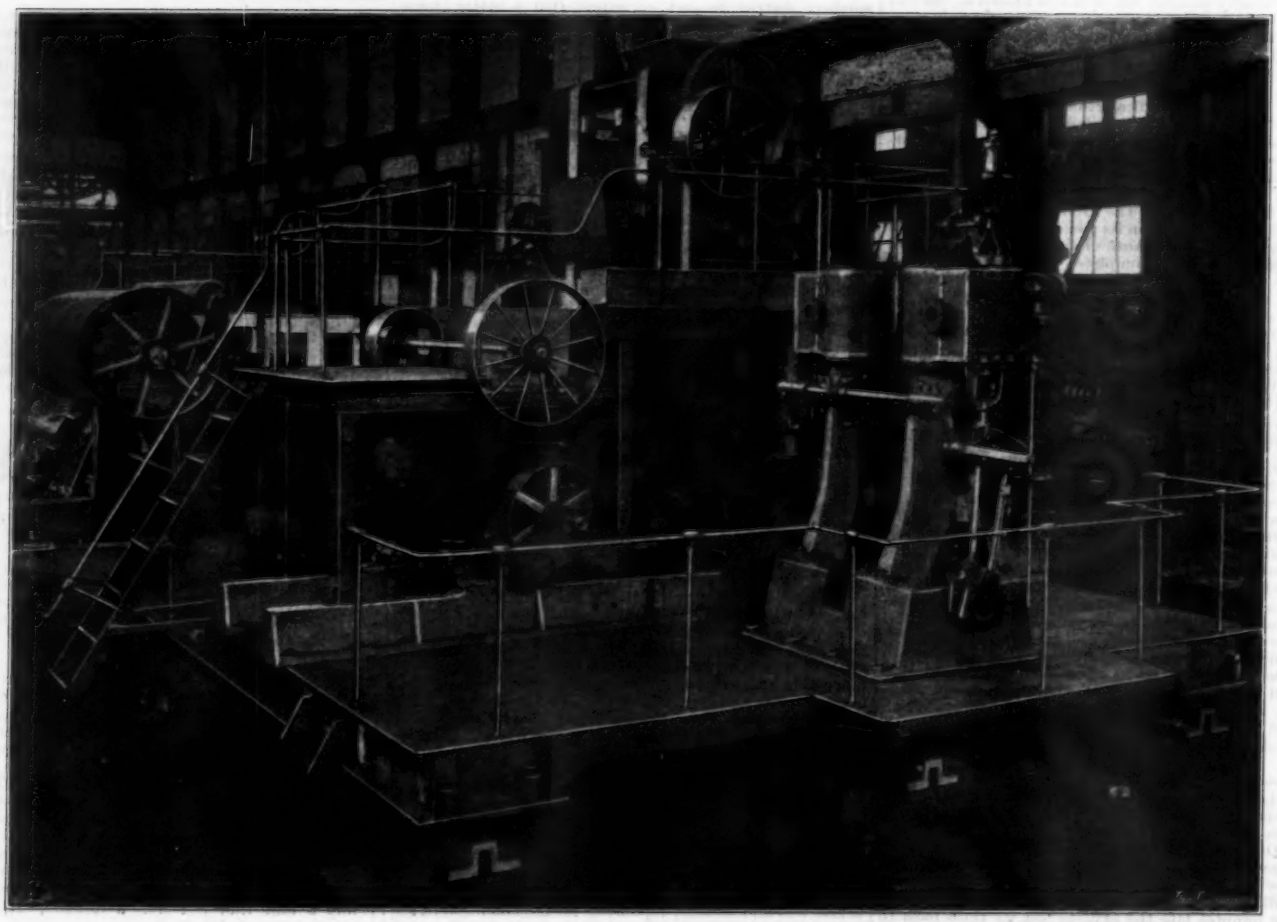

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DEATH.

ON February 2nd, at 47, Grosvenor-road, Ilford, JOHN STEPHENS, age 81 years. Director and Founder of the firm of Stephens, Smith & Co., Ltd., Engineers, Millwall.

THE ENGINEER.

FEBRUARY 5, 1926.

A Dreadnought Anniversary.

THE twentieth anniversary of the launch of H.M.S. Dreadnought falls on Wednesday next, February 10th. Some difference of opinion exists as to whether this vessel or the Warrior, of 1861, should rank as the most historic ship of the ironclad era. In our judgment the Dreadnought has the better claim to that distinction. The Warrior, it is true, was the first iron-built armoured ship, but apart from the material used in her construction, she had been anticipated by the French La Gloire, which was the first sea-going vessel of war to have armour protection. Nor can these earliest ironclads be said to have exerted on the development of naval warfare an influence comparable with that of the Dreadnought. The amazing growth in the power of ships' ordnance, which eventually revolutionised man-of-war design, dates certainly from the introduction of armour; but in its initial stages the metamorphosis was slow, and years elapsed before naval tactics were modified in deference to the new material factors which had come into play. The circumstances attending the coming of the Dreadnought were very different, the effect was immediate. In fighting power she was regarded as being so immeasurably superior to all preceding ships that her appearance caused a temporary and almost universal halt in heavy naval construction. At that period battleship design was governed by the lessons of the Russo-Japanese War, in which campaign vessels of conventional type had borne the brunt of the fighting. The dual calibre system of armament still held the field, though the tendency was to increase the weight of the secondary guns, as in the Lord Nelson, the French Danton, and the Japanese Aki, despite the manifest drawbacks from the point of view of fire control. It remained for the bold genius of Lord Fisher to apply the obvious solution to the problem by building the first mono-calibre ship. We use the word "genius" advisedly, for notwithstanding popular rumours of the day which credited foreign experts with having conceived the germ idea of the Dreadnought, it is a well-established fact that Fisher had planned an all-big-gun ship as far back as 1882. Sir Philip Watts has offered conclusive testimony on that point. The writings of the Italian constructor, Colonel Cuniberti, which are often quoted as the inspiration of the Dreadnought's design, were published more than twenty years later. It is, however, but fair to add that Mr. J. H. Narbeth, of the Royal Corps of Naval Constructors, has stated in a paper read before the Institution of Naval Architects, that the arguments of Admiral Sims, U.S.N., made "a very deep impression on the mind of Lord Fisher, and very largely supplied the impetus which determined him to ask for a one-calibre big-gun battleship."

While the tactical superiority of the Dreadnought over all her predecessors has never been seriously disputed, the political wisdom of Fisher's action is less generally conceded. The construction of this ship was something more than a landmark in naval design: it was a political event of far-reaching significance. Yet there is no doubt that the beneficial results accruing to us from the Dreadnought policy were overstated by zealous partisans of the Fisher school. The British nation was led to believe that its first group of Dreadnoughts would give the Navy both a decisive and a permanent advantage over all rivals—because other nations were declared to be lacking in the technical resources required for the construction of such monster ships of war. Strange as it may seem to-day, this naïve argument was advanced in all earnestness by naval critics of repute, and was, of course, widely accepted by the public. Germany, in particular, was assumed to be out of the running, if only because the prodigious cost of enlarging the Keil Canal, which was too small to accommodate Dreadnoughts, would be beyond her means. All these facile expectations were, of course, falsified. Germany, after no long delay, began the building of battleships on the new plan, and simultaneously set about the formidable task of reconstructing the Canal, a work that took eight years to complete. It is difficult to resist the conclusion that Germany gained more than this country by the introduction of the Dreadnought. In 1906 her fleet included ten first-class and ten second-class battleships, the latter being armed with nothing heavier than 9.4in. guns. We possessed at that time forty 12in. gun battleships, the oldest of which were fully equal, and probably superior, to the German second-class vessels. Of modern armoured cruisers we had thirty-five and Germany no more than eight. All these ships were rendered obsolete by the Dreadnought and the Invincible, which created new standards of fighting power for battleships and armoured cruisers respectively. We had thus to write off, as it were, seventy-five ships against a German total of twenty-eight. But that was not all. The reduction of battle fleets to a Dreadnought basis gave Germany a chance to resume the naval race on equal terms, and from 1906 to the outbreak of war she pressed us hard. Her largest pre-Dreadnoughts were of 13,200 tons; her first all-big-gun ships were of 18,900 tons, an increase of 5700 tons. These facts cannot be said to support the argument that in producing the Dreadnought we scored any marked advantage over our principal competitor of that period.

It is to be doubted that the world has ever displayed an interest in any other ship of war comparable to that which the Dreadnought excited. Though the features of the vessel were supposed to be confidential they soon leaked out, and were freely canvassed in the Press. At Portsmouth Dockyard, where the keel was laid on October 2nd, 1905, the building slip was screened from the vulgar gaze and a special guard posted to keep unauthorised visitors at a distance. Such procedure was new in this country, and its only apparent effect was to stimulate foreign curiosity. The vessel was built in record time, the Admiralty being desirous of testing her at sea before further units of the class were ordered. To facilitate rapid construction the lines of the hull were simplified, care being taken to provide an exceptional degree of rigidity in decks and bulkheads to fortify them against the concussion of the heavy guns. The steel sections were reduced to the smallest number possible; plates of standard sizes were adopted in order to minimise cutting and sorting, and an ample reserve of materials was maintained well in advance of progress on the ship. She was brought to the launching stage in four months and eight days, and completed for sea eleven months later, a truly wonderful performance. The Dreadnought proved a splendid sea boat, thanks to her lofty freeboard—28ft. at the bow—the pronounced flare of the forecastle, and the almost rectangular section amidships, which operated to check rolling. Mr. Narbeth has told us how one morning the Hibernia, going out for gun trials, passed the Dreadnought, "and it was with great surprise that we read in the newspapers the next day that the weather was too much for the Hibernia to attempt her trials. In the Dreadnought the bad weather had not been

noticed." As her main armament the ship had ten 12in. 45 cal. guns in twin barbettes, three on the centre line and two on the beam, giving her a broadside discharge of eight guns. This arrangement was duplicated in six later ships, and was only departed from in the Neptunes, where the wing turrets were placed in echelon and the fourth turret was raised to fire over the fifth. In the next class, "Orions," a purely centre line distribution of the turrets was adopted. One of the few conspicuous defects of the Dreadnought was her lack of a secondary armament. She mounted nothing between 12in. and 12-pounder guns. Her successors had a 4in. intermediate battery, but even it did not satisfy requirements, and eventually the well-tried 6in. gun was restored. Irrespective of her powerful main armament, the Dreadnought was unequalled in the quality of speed. At the date of her completion battleship speeds varied from 18 to 19 knots; but she had been designed for 21 knots, and on trial she attained 21.6. Contrary to what is often affirmed, she was not the first turbine-driven battleship, for that system of propulsion was first installed in the Japanese vessel Aki, which was laid down seven months before the British ship. The Dreadnought, however, was matchless in her combination of heavy armament and high mobility on a displacement of 17,900 tons, which was only 1150 tons more than that of the King Edward VII., a ship of moderate gun-power and 18½ knots speed. As Mr. Narbeth has remarked, "Critics and writers vied with each other in endeavouring to discover what had been sacrificed to carry this immense armament at the great speed of 21½ knots. It did not, however, appear to have occurred to any of them that the skill of the naval architect and the marine engineer had a good deal to do with it."

As a technical achievement the design and construction of the Dreadnought stands unrivalled in the annals of modern shipbuilding. Whether it was sound policy to spring such a surprise on the naval world is another question. As we have seen, the ultimate effect was to depreciate the relative strength of the British Navy. Nor can it be denied that the launch of the Dreadnought inaugurated that fierce competition in tons and guns which in the course of a decade had more than doubled the size of capital ships and increased their cost fourfold. Even without the Washington Treaty exigencies of national finance must, sooner or later, have imposed a check on the building of ships at £7,000,000 apiece. It is possible, therefore, that the building of the Dreadnought may prove to have antedated by many years the demise of the capital ship, a result which her creators cannot have foreseen.

The Credibility of Boiler Tests.

DURING the last year or so there have been published numerous boiler test results in which efficiencies of over 90 per cent., based on the higher calorific value of the fuel, have been recorded. In one case an efficiency as high as 92.9 per cent. has been claimed. There is no reason to doubt the good faith of those who put forward figures of this kind. They have presumably convinced themselves that their results are correct, and they generally support them by accounting with great exactness for the remaining 10 per cent. or so of the heat which has not found its way into the steam. It is, nevertheless, questionable whether other engineers attach quite the same weight to them as their authors do. The figures are undoubtedly within the limits of physical possibility, and in many branches of engineering higher efficiencies are obtainable. Moreover, if the recorded weights and measurements of the tests are accurate, the efficiencies claimed follow as a matter of simple arithmetic. The credibility or otherwise of the results, therefore, turns entirely upon the reliability of the figures from which they are computed. This statement, although it looks like a mere truism, really contains the heart of the matter. What exactly, then, do we mean by reliability, and how can we measure it? Reliability is not to be confounded with precision. The more precisely an experimental result is expressed the more cautiously should it be received. It is indeed the very preciseness with which the results of boiler tests are stated that gives rise to doubt. To say, for example, that a boiler showed an efficiency of 92.9 per cent. means, if it means anything at all, that the speaker is sure that the true value is greater than 92.85 per cent. and less than 92.95 per cent. Otherwise the final figure would be changed. It is therefore implicitly claimed that there is no possible error in the result greater than five parts in 9290, or, in other words, that the statement of efficiency is accurate within plus or minus about .05 per cent. Such a claim is extraordinary enough, but when we find boiler efficiencies given, as they frequently are, to two places of decimals instead of one, thereby suggesting ten times the accuracy of the case quoted, it will be obvious how far the craze for precision has outrun the practical possibilities of accuracy. It is by no means easy to determine even the diameter of an inch bolt with an error not exceeding .00005in., and yet the same order of accuracy is claimed for every boiler efficiency given to two places of decimals, in spite of the numerous and comparatively rough measurements on which the claim depends.

In the test to which we have referred the calorific value of the coal is given as 12,545 B.Th.U. per lb., with an implication of accuracy within plus or minus about one part in 25,000. Now, no experienced coal tester would rely upon agreement within one part in 200 between careful tests carried out on the same sample of coal by the same individual using the same apparatus. With independent samples, independently tested, there are likely to be variations of at least 2 per cent. between one determination and another. During the twenty-two hours over which the boiler test extended there were burned over 130 tons of coal. The quantity actually burnt in the calorimeter cannot have exceeded a few thimblefuls, and if we presume absolute accuracy on the part of the chemist and his apparatus, it takes a great deal of faith to believe that the microscopic fraction of the fuel which he examined was certainly typical of the bulk. How much confidence, therefore, can we repose in the statement that the average calorific value of the coal burnt was 12,545 B.Th.U. per lb.? If it were only 1 per cent. higher, the boiler efficiency would fall from 92.9 to less than 92 per cent. at once. Then, again, there is the possibility of error in the weight of the coal burnt. Weighing is supposed to be a very accurate process, and it certainly may be so. But, on the other hand, it may not; whilst even if it is, one has also to be sure that the time over which the weighed coal is burnt is the same as that over which the evaporation of the water is measured. If the quantity of coal actually burnt per hour is 1 per cent. greater than that recorded, the boiler efficiency becomes still further reduced to 91.7 per cent. A further error of 1 per cent. in the quantity of water evaporated per hour will bring the efficiency down to less than 90.2 per cent. Finally, if the recorded average pressure and temperature of the steam are both 1 per cent. higher than their true values, and the recorded temperature of the feed water is 1 per cent. less than it should be, the boiler efficiency drops nearly to 89.7 per cent., or some 3.2 points less than that claimed. It may, of course, be reasonably contended that all the errors of measurement are not likely to be in the same direction, and that therefore they will largely cancel out. According to the laws of probability, the coincidence that six independent measurements will all tend to produce the same kind of error in the result will not occur on the average more than once in thirty-two boiler tests. But the three measurements in which errors have the greatest influence—namely the calorific value and the weights of coal and water—will have their errors in the same direction on an average once in every four boiler trials, which is quite enough to give cause for anxiety. Moreover, there is always the human element to consider. It may be taken for granted that everybody engaged on a commercial boiler test would like the performance of the boiler to show up as well as possible. Doubtful readings therefore may be given the benefit of the doubt, and the records may have a slight bias for this reason alone.

If, then, by making what are really very reasonable assumptions as to possible errors of measurement, we find that there is a possible total error exceeding 3 per cent. in the recorded efficiency of a boiler, we come back to the question of how much faith may be reposed in published tests. Nothing, of course, will make allowances for carelessness or bad faith on the part of those who make the tests; but provided that these are not to be feared, there ought to be some agreement as to the limits of error to which a test is liable. The idea of a "probable error" or of a "standard deviation" is perfectly familiar to those who have to do with experimental figures, and it would be well if the residual and ineradicable uncertainty of boiler tests could be indicated quantitatively by some such means. We should, then, at least be doing something to neutralise the claims of those who put forward figures of boiler efficiency to one or more decimal places. A start might well be made by considering the reliability of the most doubtful factor of all in a boiler test, namely, the calorific value of the coal burnt. If portions of the same sample were sent to a score or more of different analysts, and the results published, we should have a fair notion of the errors due to various men and instruments. The next step would be to let a number of different analysts each select his own sample from the same bulk. From a study of the results obtained it would be easy to calculate the probable error of any determination of calorific value, made by competent men using ordinary care, and we should thus know what reliance to place upon a figure purporting possibly to be exact to one part in 10,000 or more. Similarly, the errors to be expected in weights of coal, quantities of water, temperatures and pressures might be examined, and a combination of the whole, in accordance with well-known methods, would result in a figure indicating the maximum degree of reliability of the boiler test itself. Work along these lines is far overdue. It would be of much more practical use than much of the "research" now being carried on by public or private funds, for nothing would tend to increase the accuracy of the measurements involved in boiler tests, and therefore of the tests themselves, than an authoritative pronouncement as to the magnitude of the errors usual in such measurements. The cost of obtaining the information would be very small, and, failing the Fuel Research Board, it is to be hoped that some other organisation may take up the important task of putting boiler tests upon a more satisfactory footing.

Obituary.

MARTIN MURPHY.

THE death is announced of Dr. Martin Murphy, a prominent engineer, as having taken place at St. Catharines, Ont., on January 10th, in the ninety-fifth year of his age. He was born in Ireland, and went to Canada in 1868, where he speedily acquired an international reputation for railway bridge building, being in 1870 appointed chief engineer for projected lines of railway in Nova Scotia. From 1871 to 1874 he was a contractor for bridges for the Intercolonial Railway.

Dr. Murphy occupied the position of provincial Government engineer for Nova Scotia from 1875 to 1905, and in 1913 was appointed Government consulting engineer for the Western Division of the National Transcontinental Railway construction, retiring in 1918. He served a term as president of the Nova Scotia Institute of Science, and was president of the Canadian Society of Civil Engineers in 1902 and 1903. He was a frequent and valued contributor to many professional journals and periodicals.

Literature.

Bats, Mosquitoes, and Dollars. By Dr. CHARLES A. R. CAMPBELL. Boston, Mass.: The Stratford Company. 1925. Price 3 dollars.

THIS is a very curious book. Dr. Campbell is a medical man of San Antonio, Texas. He has for many years made a study of malaria, and almost for as long a time has been carrying out investigations regarding the bat. He was not, of course, the first to discover that one of the principal foods of the ordinary bat was the malaria-causing mosquito, but he has, probably, done more than any one other single person to make that fact more widely known and to show to the world at large how it may be taken the most advantage of. At the outset he makes four statements or allegations. They are as follows:—

(1) That the malarial mosquito is one of the greatest enemies of mankind.

(2) That the bat is one of man's best friends, because it so relentlessly destroys the malarial mosquito, that insect being its natural and principal food.

(3) That we can build a home for bats in a scientific manner to meet the requirements of their singular habits, and one which they will inhabit; a home where, being protected from their natural enemies, they will increase in countless numbers and eradicate the malaria in its vicinity.

(4) That each bat roost, in addition to its great hygienic value, is in itself a little gold mine, by reason of the cash obtained from the natural high grade fertiliser, guano, which it will constantly produce.

A large part of the book is taken up by the author in bringing forward evidence in support of his contentions. He does so with a wealth of detail and a picturesqueness of phraseology and metaphor which are at once instructive and appealing. His subject may not, at first sight, seem to come within the

sphere of action of a technical engineering journal, yet, on second thoughts, it will be realised that engineers, as a body, have, more perhaps than most, to visit and work in countries where malaria is rife, and anything which may aid them in fighting the pest should be welcomed.

We do not propose to follow Dr. Campbell through all the mass of evidence which he has got together regarding either the widespread prevalence of malaria or the fact that the ordinary bat does feed principally on the nocturnal variety of mosquitoes termed *anophelines*. Both are indisputable. The particular interest of the book, to those whose duties take them into malarial areas, is that Dr. Campbell claims to have discovered how to construct homes or roosts which the bats will take to and live in, so that in future it will be possible to provide living and breeding-places for the little animals which, as he convincingly proves, so greatly reduce the numbers of mosquitoes as to make them, to all intents and purposes, a negligible factor in the neighbourhood in which they operate. He does not, in this connection, ask his readers to rely solely on his own unsupported assertions. He goes so far as to reproduce the testimonies, sworn to before a notary public, of numerous dwellers near his first successful bat roost, and, in passing, it may be said, he was successful at his second attempt. One and all these witnesses assert that (*a*) whereas before the bat roost was built in their vicinity life, even in the day-time, was a misery, while work at night in the open air was an impossibility, and existence only bearable inside a mosquito curtain; (*b*) immediately after the roost was built and inhabited by bats, conditions began to improve, and it was very soon possible to carry out irrigation work at night with immunity from mosquito bites.

The great thing, having built your bat roost where you want it, is to make sure that the bats will inhabit it. We are accustomed to connect these little mammals with old barns and such-like buildings, and not with new structures, but Dr. Campbell has discovered how to make quite new buildings acceptable to them. It appears that the interiors of any places occupied as dwellings by bats, smell very strongly of ammonia, which is produced by the decomposition of their droppings. As the result of years of observation, Dr. Campbell noticed that after their periods of night-hunting for food, the bats always approached their dwelling-place from a great height vertically above it, and he formed the opinion that, although the bat is undoubtedly possessed of a wonderfully keen sense of direction, and always knows which way to fly back to its home, no matter how far it may be away, it is finally directed to its abode by the sense of smell. In this surmise he proved to be correct. He found that by leaving a piece of coarse cloth for some months on the floor of a large cave, thickly tenanted by bats, the material not only became covered to some considerable depth by droppings, but took on a very decided ammoniacal odour. Removing that cloth to the special roost he had constructed, he discovered that, after some little time, the bats visited it, though they did not stay in it, so he set to work to find out why. Then followed a long comparative study of the structures of caves inhabited and not inhabited by bats, and finally Dr. Campbell became convinced that he "had discovered the likes and dislikes of these anomalous creatures regarding the architecture of their homes," and again he was correct. Having made certain structural alterations in his roost, he found that the bats remained in it when they had once visited it. Roosts since constructed in various parts of the world have been equally successful.

The figures which Dr. Campbell places before his readers are astonishing. "It would," he says, "be very conservative to estimate the number of bats as permanent residents at the Mitchell's Lake bat roost* at 250,000, though when the period of migration is well established the number could be just as conservatively estimated at more than half a million." By a process of investigation, into which we have not space to go, Dr. Campbell estimates that each bat, each night between, say, nine o'clock and three o'clock in the morning, will consume no fewer than 3375 mosquitoes. That means that no fewer than 843,750,000 mosquitoes would be devoured in the course of six hours by 250,000 bats! Hardly less astonishing, perhaps, is the quantity of guano harvested per annum. During an average year, some 3000 lb. are taken from the Mitchell's Lake roost. The quantity has been known to exceed 4550 lb. "In bat guano," says the author, "she [Nature] distributes the iron, potash and sulphur in those exact proportions that make it as ideal a food for plant life as is milk for the human." In analysis carried out by the State Chemist at the Agricultural and Mechanical College of Texas, it was ascertained that the bat guano submitted by Dr. Campbell the percentage of phosphoric acid was found to be 4·52 and of nitrogen 15·75. Iron was found to be present to the extent of 3 lb. per ton, potash to the extent of 14 lb. and sulphur to the extent of 29 lb. The commercial value of the guano is certified as being 117·10 dollars per short ton.

We are not told very much about the internal construction of Dr. Campbell's bat roosts, saving that they contain sloping shelves, but from views of several different roosts built in America and Europe, it can be seen that the structure is built up on a square base — measuring perhaps 14ft. or 15ft. in every direction—this base standing on four columns one at each corner. Protection discs are formed round each column to prevent preying animals finding their way up them. On the square base is erected a tapering structure not unlike what a hop kiln would be were it square, and on the top is a square roof with sloping eaves. Apparently, the building is about 45ft. or 50ft. in height. A bat roost of these dimensions would, it is stated, cost from 2500 to 3500 dollars—say, from £500 to £700—"according to how fancy or pretentious it is desired to make." The crop of guano will, says Dr. Campbell, go on paying from 5 to 10 per cent. on the original outlay, and there will be some further revenue if arrangements are made, as he has done, to include in the structure lead trays that may contain sulphuric acid, which, combining with the ammonia fumes, may produce another fertiliser, ammonium sulphate.

* The first successful structure.—ED. THE E.

SHORT NOTICES.

The Disease of Unemployment and the Cure. By Sir Ernest W. Petter. London: Hutchinson and Co., Ltd. 1925. Price 1s.—The nature of Sir Ernest Petter's pamphlet is so nearly political that we hesitate to say anything about it. He is "again the Government," because it has not the grit to embark on Tariff Reform, and because it re-established the gold standard. Those who sympathise with these views will admire the lucidity with which the author expresses his opinions; those who do not will resent the absence of contra arguments. The most striking of the proposals put forward by Sir Ernest, apart from a return to inflated currency, is that instead of lowering the excessive wages of those engaged in the sheltered industries, we should raise those of workers in the unsheltered industries until a correct relationship is reached. We find it difficult to see the end of that practice. Fortunately, the indications at the moment are different from those which prevailed in the late autumn, when the pamphlet was written. Unemployment is falling, foreign competition is not flourishing, and it looks as if the country were about to recover from its depression without the application of the heroic measure proposed by our author.

Processes of Flour Manufacture. By Percy A. Amos. New edition revised by Jas. Grant, M.Sc. Tech. London: Longmans, Green and Co. 9s.—This is the third edition of a very instructive little volume written by the late Mr. Percy A. Amos, who was Lecturer on Milling at the Manchester Municipal College of Technology. Mr. Amos was killed in the Great War, and the publishers have entrusted the work of partially rewriting the book and bringing it up to date to Mr. James Grant, M.Sc. Tech., who is head of the Foodstuffs Department in the above-mentioned College. In addition to several new illustrations, further examination papers, a bibliography, a chapter on general principles and the chemistry of the wheat berry have been inserted. We can cordially recommend this work to all students of flour milling and the cognate industries.

BOOKS RECEIVED.

"*Mechanical World*" *Electrical Pocket Book*, 1926. London: Emmott and Co., Ltd., 20, Bedford-street, W.C. 2. Price 1s. 6d. net.

The Technology Reports of the Tôhoku Imperial University, Sendai, Japan, Vol. V., No. 4. Tokyo and Sendai: The Maruzen Company, Ltd. 1925.

The "*Practical Electrician's*" *Pocket Book*, 1926. Edited by H. T. Crewe. London: S. Rentell and Co., Ltd., 36, Maiden-lane, W.C. 2. Price 3s. net.

Laboratory Experiments for the Engineering Student, Part II. By H. Threfall. London: Chapman and Hall. Ltd., 11, Henrietta-street, W.C. 2. Price 4s. net.

Report on the Financial and Economic Conditions in Paraguay. By F. W. Paris. London: His Majesty's Stationery Office, Adastral House, Kingsway, W.C. 2. Price 1s. net.

The Elements of Reinforced Concrete Design. By H. V. Crabtree. London: The Association of Engineering and Shipbuilding Draughtsmen, 96, St. George's-square, S.W. 1. Price 2s. net.

German Iron and Steel Production in 1925.

DURING nearly the whole of last year the Rhenish-Westphalian iron and steel makers were complaining—and are still complaining—of the unfavourable situation of the industry, the continued fall in sale prices even after the formation of control syndicates for almost all branches of production, of the blowing out of blast-furnaces one after the other, and the ruination of the home and foreign markets owing to the competition of neighbouring countries in consequence of their depreciated currency. Yet despite the operation of these conditions, the Germans in reality have no reason for being dissatisfied with the total results for the year when considered from the standpoint of the production of iron and steel.

This fact is illustrated by the statistics for 1925 which have just been issued by the Association of German Iron and Steel Manufacturers. Although the output of pig iron, which was as high as 909,800 tons in January, and 990,600 tons in March, declined to 760,000 tons in November and further to 717,000 tons in December, the total production for the whole of the year amounted to 10,176,000 metric tons, and represents an increase of 2,364,000 tons over the output of 7,812,000 tons in 1924. Noteworthy in this connection are the circumstances that the quantity of 10,176,000 tons is not very far distant from the tonnage of 10,900,000 which was turned out within the present territorial limits in 1913, and that the 1925 production was accomplished with only about one-half of the number of blast-furnaces that were in operation in 1913, thus showing how the furnace output capacity has been increased. Thus, the number of such furnaces which were in activity in the same area in 1913 was 203; at the beginning of 1925 there were 113 in service, 122 in March, 120 in May, but the number declined to 93 in November and further to 83 at the end of December. The productive capacity of the total of 211 blast-furnaces existing throughout Germany is returned at 47,820 tons per twenty-four hours.

The production according to sorts last year was as follows:—Hematite, 826,114 tons; foundry pig and direct castings, 1,328,791 tons; acid Bessemer, 36,555 tons; basic Bessemer, 5,940,267 tons; steel making pig iron, spiegeleisen, ferro-manganese and ferro-silicon, 2,020,160 tons; forge pig, excluding spiegeleisen, and various sorts, 24,812 tons.

The diminution in the monthly production of pig iron was accompanied by a similar decline in the output of steel, which reached its maximum of 1,209,000 tons in March, and then gradually receded to 873,000 tons in November and to 763,000 tons in December. The total for the entire year is returned at 12,193,000 metric tons, as compared with 9,835,000 tons in 1924, or an augmentation of 2,358,000 tons. As the production of steel within the present geographical limits in 1913 amounted to 11,466,000 tons, the remarkable fact is shown that the actual output in 1925 represents an increase of 727,000 tons.

According to qualities, the production of steel ingots in 1925 was as follows:—Basic Bessemer, 5,110,646 tons; acid Bessemer, 22,448 tons; basic open hearth, 6,474,168 tons; acid open hearth, 149,293 tons; and crucible and electric steel, 127,944 tons. The steel castings made comprised 189,102 tons on the basic process, and 108,125 on the acid process, whilst 11,728 tons were crucible and electric steel castings.

As the formation of syndicates in various branches of the iron and steel industry has failed to bring about an improvement in sale prices, and the industry is working at a general restriction of 35 per cent. in the production, calculated in steel ingots at total allotments of 14,700,000 tons in the Ingot Steel Syndicate, four of the large groups of coal and iron and steel makers have provisionally decided to amalgamate their undertakings with a share capital of approximately 700,000,000 marks (£35,000,000). As already reported, these groups are the Phœnix Company, the Thyssen group, Rheinstahl and the Rhein-Elbe Union for the Gelsenkirchen Company and the Bochum Verein. A preparatory company has just been formed with a share capital of 50,000 marks to make arrangements for the definite constitution of the United Steel Works Company, which is the title given to the new undertaking. Whether the scheme will actually be carried out appears to depend upon whether it will be possible to get considerable relief in the taxes which would have to be paid on the establishment of the company. If this matter can be arranged satisfactorily with the Government and the many local authorities concerned, the promoters will then proceed with the work of securing the necessary financial assistance in order to bring the project to a successful issue. The four groups would control a coal output of over 40,000,000 tons per annum and a steel production of about 6,000,000 tons, so that a considerable output, both of coal and steel, would still remain outside the scope of the proposed trust.

If the scheme should be successfully brought into existence, the promoters consider, judging from the statements made at recent annual meetings of two of the companies concerned, that it will be the means of bringing about a reduction in the costs of production by the distribution of the orders among the particular works which are best adapted for the purpose from the standpoint of equipment, plant, and the geographical situation from the point of view of transport of iron ore and the sending away of manufactures. The hope is also expressed that the scheme will enable the Germans again to take a larger part in the export trade and at the same time successfully to cope with dumping by foreign competitors as a result of depreciated currency.

FINISHED STEEL PRODUCTION.

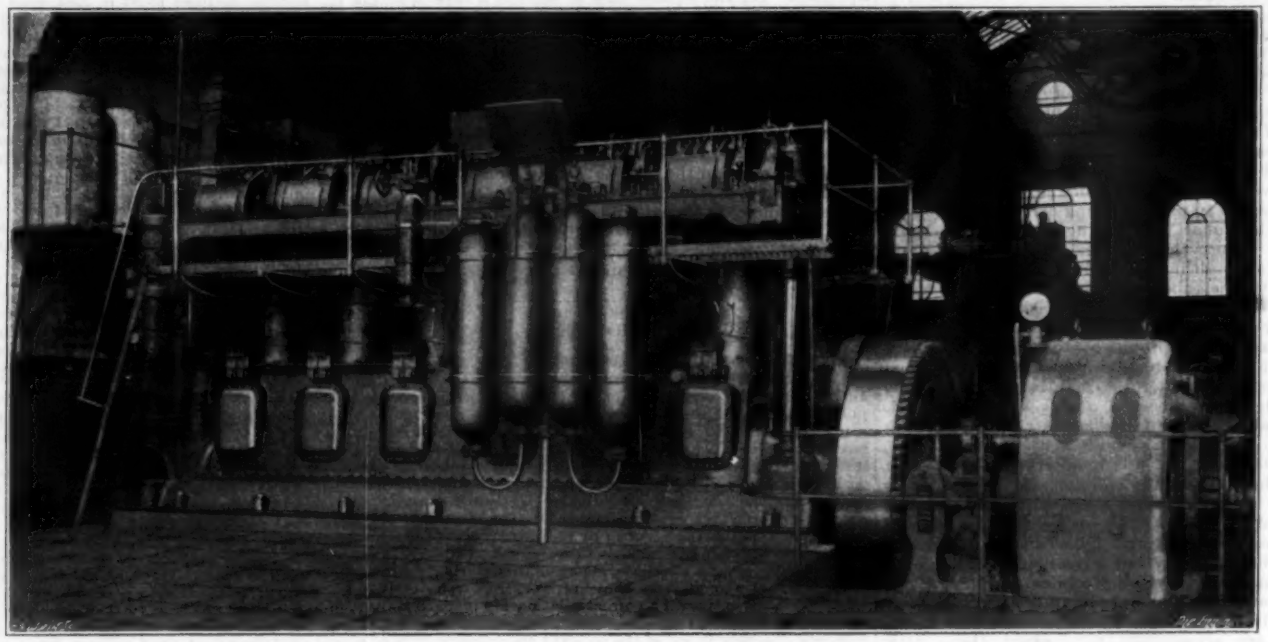
As might have been expected from the expansion in the production of pig iron and steel ingots in 1925, the output of finished iron and steel products in Germany in 1925 showed a considerable increase over the preceding year. As recorded by the statistics collected by the German Association of Iron and Steel Manufacturers, the production of the rolling mills and forging and pressing works connected with them amounted to 10,246,199 metric tons, as contrasted with 8,174,320 tons in 1924, being an increase of 2,071,879 tons. The monthly average in 1913 was 1,391,579 tons.

Quite nine-tenths of the production of steel ingots in 1925 were worked up by the makers themselves, the quantity intended for the market having been 951,000 tons in round figures, as compared with 829,000 tons in the preceding year. With one notable exception an augmentation took place in all the products turned out last year. For instance, the production of permanent way material rose from 1,052,000 tons in 1924 to 1,498,000 tons; shapes from 460,000 tons to 676,000 tons; bars from 2,321,000 tons to 2,839,000 tons; hoops from 281,000 tons to 389,000 tons; wire rods from 908,000 tons to 1,072,000 tons; plates from 766,000 tons to 833,000 tons; medium sheets from 122,000 tons to 173,000 tons; light sheets from 486,000 tons to 722,000 tons; tin-plates from 86,000 tons to 91,000 tons; tubes from 476,000 tons to 636,000 tons; forgings from 128,000 tons to 183,000 tons; and other products from 45,000 tons to 59,000 tons. The exception to the general augmentation applies to railway wheels, axles, &c., the production of which diminished from 206,000 tons in 1924 to 119,000 tons last year.

The total production in 1925, namely, 10,246,000 tons, represents about two-thirds of the output in 1913, and although the progress over 1924 is shown to be considerable, it has to be remembered that the latter year was one in which the works began to recover from the so-called passive resistance in the Ruhr. The average daily production in 1925 is stated to have amounted to 33,594 tons, as against 26,627 tons in 1924. Simultaneously with the general expansion in the output, there was a large growth in the export trade, and for the eleven months ended with November 3,174,000 tons were sent out of the country.

600 B.H.P. OIL ENGINE AT BASINGSTOKE

MIRRLEES, BICKERTON AND DAY, LTD., STOCKPORT, ENGINEERS



A 600 B.H.P. Oil Engine Generator Set.

DURING a recent visit to the works of Mirrlees, Bickerton and Day, Ltd., at Hazel Grove, Stockport, we saw going through the shops and in course of erection examples of a new type of engine, which is intermediate between the standard sizes of 80 and 125 brake horse-power per cylinder units, which the firm has now been building for some years. The new model is designed for an output of 100 brake horse-power per cylinder at the moderate speed of 250 revolutions per minute, and it will be built in three to six-cylinder units up to 600 brake horse-power. Later on the new size may also be built as an eight-cylinder engine of 800 brake horse-power.

In an article which appeared in THE ENGINEER for May 26th, 1922, we described and illustrated some of the special jigs and tools used in the Hazel Grove works. On the occasion of our recent visit we noted still further developments in the manufacturing process which have been introduced to secure rapid and economical output, combined with extreme accuracy.

THE BASINGSTOKE INSTALLATION.

A particular engine of the new type above referred to is the six-cylinder 600 brake horse-power engine coupled to a 410-kilowatt direct-current generator, which was recently installed at the electricity works of the Basingstoke Corporation. A general view of the new set is given above, and in the following table we give the principal particulars of the engine and its generator, together with some of the results which were obtained at the recent official trials which were carried out at the engine makers' works.

Engine Particulars.

Type—Mirrlees four-stroke cycle enclosed type, with air injection	
Number of cylinders	Six
Diameter of cylinders	17¾in.
Stroke of piston	20in.
Normal speed	250 r.p.m.
Designed output	600 B.H.P.

Results of Official Full Load Test Bed Trials.

Duration of trial	Six hours
Mechanical efficiency	82·4 per cent.
Mean effective pressure	82·3 lb. per sq. in.
Average fuel consumption, per B.H.P. hour	0·375 lb.
Guaranteed fuel consumption, per B.H.P. hour	0·41 lb.
Calorific value of fuel oil	18,200 B.Th.U. per lb.

Generator Particulars.

Type—Newton's Ltd., standard continuous current generator	
Designed output	410 kilowatts
Normal running speed	250 r.p.m.
Generator voltage	460–500 volts
Fuel consumption, per kilowatt-hour	0·558 lb.

In many respects the engine above illustrated follows the firm's standard practice for engines of the enclosed type. Forced lubrication is fitted to all the main bearings, and the oil supply is maintained by a valveless pump of high capacity. A separate hand pump is also fitted, so that the main bearings can be flooded before the engine is started up. Large inspection doors are provided on the crank case, and they are secured by closely spaced studs which effectively prevent any escape of lubricating oil. It will be seen from the illustration that the engine controls are arranged to be worked from the top platform, the starting air and blast receiver hand wheels being conveniently grouped a little above platform level.

A noteworthy feature of the engine is the unusually long connecting-rod employed; it is over 5·65 cranks in length. The makers claim that the lengthening of the connecting-rod reduces the forces which cause vibration, and so tends to lessen cylinder wear, whilst the amount of lubricating oil which is splashed on to the cylinder walls is greatly reduced. The engine is fitted with aluminium pistons which have been employed in Mirrlees engines of both large and small powers for some years. With an aluminium piston the stress on the connecting-rod bolts is diminished, and less vibration is set up.

The cylinder covers are standard in design, but the firm's packingless fuel valve is fitted to each cylinder. This valve, it will be remembered, was first exhibited at Wembley in 1924. Several of these valves were seen under construct on and in course of testing, and we particularly noted their flexibility, which prevents any jamming, which might otherwise take place were the bolts of the fuel valve casing screwed down unequally.

As already mentioned, air injection is employed, and this system is used on all Mirrlees engines, except those of small power in which low first cost is the prime essential. In such engines mechanical injection fuel valves are fitted. It was pointed out to us that on the Basingstoke engine the smallest hole through which the fuel has to pass is $^1/_{13}$in. in diameter, there being thirty-two such holes in any one ring of the pulveriser. If it be assumed that a mechanical injection jet is to be designed for an engine of similar power, it would probably be provided with five holes of about $^{12}/_{1000}$in. in diameter. Keeping these figures in mind the makers claim that with air injection there is less likelihood of a choked fuel jet. We reproduce

DIAGRAM FROM BASINGSTOKE ENGINE

a full-load indicator card taken from the Basingstoke engine during the trials. It shows that the maximum compression pressure of 480 lb. per square inch is not increased during the fuel injection period. Another feature of the air injection system which the firm claims is that some supercharging takes place owing to the compressed air used for spraying the fuel into the cylinder, and this extra air makes it permissible to utilise additional fuel, with the result that a higher mean effective pressure is obtained. Yet it should be noted that the mean effective pressure adopted in this new type of Mirrlees engine is as low as 82·3 lb. per square inch, from which it is obvious that reliability has been kept in mind. Such a moderate rating allows a good margin for overload working, which is of particular advantage in the case of engines which are to work in tropical countries.

The experience of the makers is that where air injection is employed it is not necessary to filter the fuel oil particularly well, owing to there being no small openings in the pulverisers, and that, as there is no danger of choking, the load can be equally divided over the cylinders of a multi-cylinder unit, which is of great importance when engines are used to drive alternators which have to run in parallel.

The dynamo was constructed by Newton's Ltd., of Taunton, and is of the firm's standard design for large units. The field magnet system is provided with equalisers, which are connected to slip rings for use with a static balancer on a three-wire system.

The trials we have referred to were supervised by Mr. F. Swarbrick, the borough electrical engineer for Basingstoke, and by Mr. E. B. Thornhill, who acted for the insurance company, in whose hands the installation has been placed.

Testing Static Transformers.

SOME useful practical information on the testing of static transformers is given in a paper presented by Messrs. Lindley Thompson and H. Walmsley at a meeting of the Institution of Electrical Engineers, held on Thursday, January 21st. The usual methods adopted in the commercial testing of transformers are described, and it is shown how accuracy may be secured. The drying out of transformers, the determination of dryness and the measurement of insulation resistance are discussed, and the measurement of the iron loss and the load loss is described. The measurement of form factor and its effect on the loss measurement are also dealt with. Methods for determining the ohmic resistance are given, together with the corrections that should be made. Other matters considered are the loading of transformers for a full load test, over-potential testing and methods of measuring high voltages. For testing the ratio of a transformer, the authors appear to favour the resistance balance ratio-meter method, as it is not subjected to the same inherent errors as other methods, and accuracy can be obtained over a much greater range. Several polarity tests are described, but the authors do not express any opinion with regard to any of them.

The iron loss and magnetising current are measured by supplying the normal voltage at the correct frequency to one winding of the transformer, with the other winding open-circuited and the voltage and frequency are adjusted to the correct values. The wattmeter reading then gives the iron loss and the ammeter the no-load current, which is made up of a watt component due to the energy loss and a wattless component due to the magnetisation. As the power factor can be obtained, the wattless or magnetising current can be calculated. With large transformers the magnetising current is almost equal to the no-load current, but with small transformers there is an appreciable difference. The no-load power factor varies according to the size and frequency of the transformer under test, and comes within the range of approximately ·2 and 0·06. This necessarily results in small readings on the wattmeter, and therefore possible errors in reading, and to overcome inaccuracies of reading it is essential that a wattmeter should be used that is designed for low power factor work. For three-phase iron-loss measurements several instruments are necessary, unless some special change-over device is used for putting the same instrument in the different phases in turn. Two well-known methods are available, namely, the two-wattmeter and the three wattmeter methods, each of which gives accurate results if suitable instruments are employed. Suitable change-over arrangements are illustrated and described in the paper for reducing the number of instruments.

Easy and accurate measurement of frequency, the authors state, is of vital importance in transformer testing, for more than 25 per cent. of inaccurate results can be traced to insufficient care in obtaining a true reading. The authors advocate the use of a series of frequency meters of the electromagnetic type connected to slip rings on the armature of the direct-current driving motor of the motor generator testing set. The direct-current voltage of this driving motor is usually pretty constant, which is essential for accurate results. Several advantages are claimed for this method.

When measuring the iron loss of three-phase core type transformers by the three-wattmeter method, the losses measured in the three phases are never equal and in some instances a negative reading is obtained in one of the outer phases, this being accounted for by the unbalancing of the magnetic flux in the core due to its shape. This matter is fully explained in the paper, but we will pass on to the section dealing with iron loss and form factor. The iron loss of any particular transformer may be measured directly by the method described, but unless the applied voltage has a sine wave form the results will differ from the estimated or correct loss. If the wave form be peaked, having a form factor—R.M.S. volts divided by average

volts—greater than 1·11, then the measured loss will be lower, whilst if the wave form be flat with a form factor less than 1·11 the measured loss will be too high. On account of the nature of the load on the machine, the wave form will generally be peaked and the measured losses will be low. Since the form factor of the wave does not affect the eddy loss in the same manner as the hysteresis loss, it is necessary, if a correction is to be made, to separate the loss into its two components and correct the hysteresis loss in line with the form factor. The following table shows the effect of form factor on hysteresis loss, the effect at a form factor of 1·11 being taken as 100 per cent.:—

Form factor.	Relative hysteresis losses, per cent.
1·0	118
1·05	119
1·11	100
1·15	94·5
1·2	88·2
1·3	77·6
1·4	69·3

When it is remembered that the hysteresis loss forms by far the greater proportion of the total loss, any increase in the form factor will appreciably reduce the measured loss, and so give erroneous results.

The paper describes two methods of making the correction for form factor:—(1) By obtaining the form factor of the applied voltage and correcting the hysteresis loss in line with the form factor; and (2) by applying an equivalent voltage to compensate for the form factor by means of an instrument termed an iron loss voltmeter. To carry out the correction for form factor by the first method, it is essential to obtain the correct wave form of the applied voltage or its form factor. This can be done by means of the oscillograph, which gives a picture of the wave that can be analysed. A special scheme devised by the authors involves the use of thermionic valves, and is shown in Fig. 1, which is a four-valve

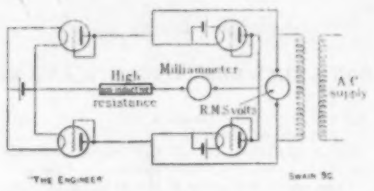


FIG. 1—FOUR-VALVE FULL-WAVE RECTIFICATION.

full-wave rectification scheme. The valves are connected in bridge form, and across the bridge the rectified direct current is caused to flow through a standard high non-inductive resistance and a milliammeter, thus giving a means of obtaining the rectified voltage or the average alternating current voltage. On testing the apparatus on a machine specially designed to give a sine wave form of voltage the actual form factor was given correctly when allowance had been made for the valve impedance which is constant for a particular valve.

Many tests were taken as a check on distorted waves and the form factors corresponded almost exactly to that obtained from the actual wave as recorded by the oscillograph. The authors claim the tests to be accurate within 0·5 per cent. In addition to obtaining the form factor, the losses measured must be separated into the two components, hysteresis and eddy current loss, because since the form factor affects only the hysteresis loss that component must be obtained. The separation of losses can be carried out in accordance with several methods, one of the methods recommended being to measure the loss at constant voltage and varying frequency, and to plot it against $1/f^{0.6}$. This should be a straight line, and the point where it cuts the vertical axis gives the eddy current loss in watts. Having obtained the hysteresis component and the form factor, the hysteresis loss should be multiplied by

$$\frac{(\text{Form factor})^{1.6}}{(1{\cdot}11)^{1.6}}$$

The second method of correction for wave form, namely, that of applying a compensated voltage value in line with the form factor is simple and easy in operation, but depends entirely on the calibration of an instrument termed an iron loss voltmeter, particulars of which are given in the paper. Temperature has very little effect on the iron loss measurement, and is usually neglected. The eddy current loss decreases slightly with increase in temperature, depending on the temperature coefficient of resistance, which for transformer iron is approximately 0·00077 between 20 deg. Cent. and 100 deg. Cent. In other words, the eddy current loss may be reduced by ·077 per cent. for every degree increase of temperature.

The measurement of copper loss is usually carried out by an arrangement of instruments similar to that used for iron loss measurements, except that one winding of the transformer, usually the low tension winding, is short circuited, and a supply capable of circulating the full load current at the correct frequency is connected to the other winding. The measured loss is composed of two losses, that due to the ohmic resistance of the copper and that due to the stray losses, termed eddy current losses. The ohmic resistance loss is the product of the ohmic resistance and the square of the current. The stray losses are brought about by induced currents flowing in small local circuits within the copper windings, terminal straps and surrounding metal, and generally depend on the strength and extent of the leakage fields. The loss is proportional to the square of the frequency and to the resistivity of the particular metals. The ratio of the ohmic loss to the eddy loss varies for different transformers, and is dependent on their characteristics, such as their reactance, current, and copper section. The separation of the losses can be carried out by two methods:—(*a*) By calculating the ohmic loss from the measured resistance of the transformer windings, and subtracting this loss from the measured loss, which gives as a result the eddy current or stray losses; and (*b*) by taking several readings of the watts lost and the frequency, whilst keeping the load constant. The watts lost plotted against the square of the frequency is a straight line, and the loss at zero frequency is the true ohmic loss. After dealing with measurements of resistance and full load temperature runs, the authors consider insulation tests, and under the latter heading over-potential tests, pressure tests between high-tension windings and the low-tension windings and core and pressure tests between the low-tension windings and the core are considered.

The paper also describes a scheme for an over-potential test on a high-voltage transformer. Connected across the high-tension windings—in the case under review the high-tension terminal and earth—is a spark-gap with the correct size of spheres, and between the gap and earth is a high ohmic resistance of a value equal to approximately 1 ohm per volt of the test voltage. The best resistance is a column of water, preferably running water, so that a constant resistance is maintained. The absence of resistance in series with the gap is not advisable owing to the severe stress put on the windings when the gap flashes over. The tappings on the high-tension windings are bridged with a static voltmeter as an indicator. Inserted between earth and the earthed end of the winding is an ammeter which gives the capacity current to earth and so is of service in determining the capacity of the windings to earth if the frequency is known. Across the low-tension side of the transformer under test is a voltmeter or a potential transformer, with a voltmeter across the secondary side.

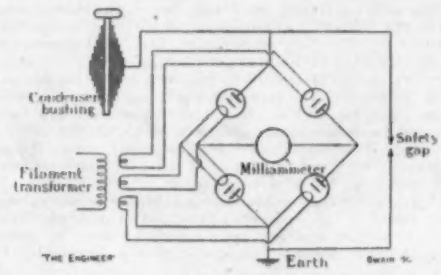


FIG. 2—FOUR-VALVE CREST VOLTMETER

The gap is set to the required voltage and the high-frequency alternator runs up to the lowest frequency at which it is estimated that the required voltage can be obtained. The alternator is then excited with a weak field and this is gradually increased in strength until the gap flashes over. At this point the voltmeter reading is noted and the supply cut off. When the transformer is dead, the spark-gap is disconnected from the terminals, and the voltage raised to the same value as that previously recorded on the voltmeter. The voltage across the high-tension side of the transformer will be that at which the gap sparked over, and the static voltmeter confirms this by giving the same reading as before. The test voltage is maintained for the required period and then gradually reduced to zero and the supply cut off. While this test is being carried out a critical examination should be made of the transformer, and the instruments in circuit should be watched for fluctuations. If the oil is visible it should be closely watched for bubbles, which may burst into puffs of smoke, indicating creepage. Should a violent disturbance occur, it points to a flash-over. If the disturbance be accompanied by large volumes of smoke, then it is fairly certain that a breakdown has occurred and must be located later. Should any of the foregoing defects arise the actual point on the oil surface will give some guide as to the region in which the failure has occurred. In many instances the oil is not visible, and in these cases the transformer must be carefully listened to by contact with the tank, and the instruments must be closely watched. Variations of hum or any crackling sounds, &c., should be noted.

If a failure occurs and the machine is automatically disconnected the test should be repeated, and if the voltage can again be maintained the fault may be attributed to a flash-over, which has probably occurred across the oil from the nearest point to earth or possibly between adjacent leads and tappings. Air bubbles are also liable to cause flash-overs, but ionisation quickly disperses them.

If the voltage gradually falls with repeated tests, the fault is almost certain to be due to creepage across the insulation, which is thus being gradually weakened. If the voltage can be maintained only at a low value the fault is then certain to be a dead earth or a short-circuited turn or turns in the winding.

When abnormal tests are required, such as three or four times the normal voltage, a high frequency is necessary to obtain this test value. With high-voltage transformers very high frequencies are apt to bring about complicated conditions and troubles. These high-frequency tests set up intense static fields and discharges under oil, causing flash-overs and disruption. Several instances of such trouble are on record, and it is recommended that a frequency not greater than 175 be used for high-voltage testing and over-potential testing.

Where abnormal tests necessitating a higher frequency than 175 periods, are required the authors have devised other means of obtaining the voltage without creating disturbing conditions. The method used involves two sources of supply, one at a high frequency, say, 200, and another at 50 or 66·6 periods, and the superimposition of one supply upon the other. The resultant wave is a distorted one, but the period of maximum voltage is not less than the lower frequency of supply. To obtain the best condition the higher frequency should be a multiple of the lower frequency, thus giving a regular peak voltage.

If the transformer has unearthed windings then a pressure test to the core or earth is required, and is carried out by the application of a high pressure between the high-tension winding and earth, the low-tension winding being earthed during the test. The high pressure must be applied to both terminals of the high-tension winding being tested, and also to the tappings should there be any, so as to preclude any pressure drop through the windings, which might occur if it were only applied at one point. The test pressure should be obtained from a testing transformer of ample kilovolt-ampère capacity to deliver the full test pressure and energy required without strain or drop in voltage, and the frequency of supply should not be lower than that for which the transformer under test is designed.

The test pressure should be measured in a similar manner to that described under over-potential tests, *i.e.*, by a spark gap or a crest voltmeter.

The crest voltmeter operates on the principle that the average charge current of a condenser is proportional to the maximum impressed voltage. To obtain the average value of the charge current it is necessary to rectify the alternating current and measure its value on a direct-current milliammeter.

In order to use the crest voltmeter, the testing transformer must be fitted with a condenser bushing or a fixed standard condenser. The condenser bushing is generally used, the earth band of the bushing being insulated from the tank and the charge current passed through thermionic valves or mercury rectifiers to earth. The rectified current is measured by a direct-current moving coil permanent magnet milliammeter.

Two circuits which give satisfactory results are given

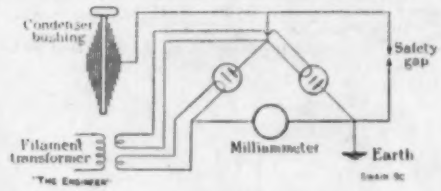


FIG. 3—TWO-VALVE CREST VOLTMETER

in Figs. 2 and 3, which show the full-wave and the half-wave rectification respectively. The full-wave rectification method is to be preferred, as the current measured is approximately twice that of the half-wave rectification, depending on the total impedance of the valves and condenser circuit. The filaments of the valves must be heated by separate supplies, except where the two-valve filaments are connected. Thus for full-wave rectification three separate sources of supply for filament heating are required and two sources for the half-wave rectification. Accumulators are satisfactory where small rectifying valves are used, but it will be found more convenient and satisfactory to heat the filament from a transformer with the required separate low-tension windings. A very small pointed spark gap is shown in the diagram across the condenser and the earth terminal. This is to take the main charge current when a heavy current passes through the terminal bushing condenser, which would otherwise spark

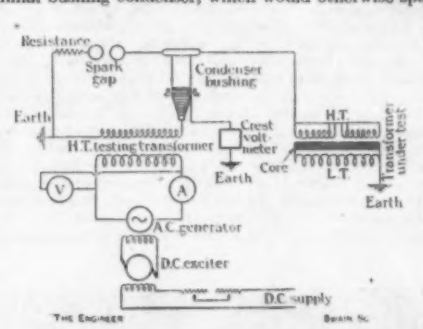


FIG. 4—CONNECTIONS FOR PRESSURE TEST

across between the plate and filament of the valves and probably burn them out. Sparks pass across this gap at every breakdown of the high-tension circuit of the testing transformer, and therefore provide a good indication of a breakdown as well as functioning as a safety device.

The charging current of a condenser being proportional to the frequency, capacity and voltage, it is very important that the frequency should be kept constant during calibration and when using the above method.

A zero error will be noticed when using either of the circuits, but this can be allowed for if necessary. It is caused by the emission of electrons from the filament to the plate sufficient to reduce it to a negative value lower than the filament and is called the space charge. When using the two-valve circuit, this can be compensated for by inserting in the earth lead a number of cells sufficient to reduce the plate voltage to a negative value low enough to stop the emission, but no very great advantage results from its use, except in connection with very low readings.

The possible errors and disadvantages of the crest voltmeter may be briefly summed up as those due to change in frequency of the charging current, and apparent change in the condenser capacity due to corona stresses and to the rectification characteristics of the valves. If the crest voltmeter is checked periodically by means of the spark gap no trouble should be experienced.

The grids of the valves are left insulated—as shown in the diagram—but if the voltage across the valve is sufficiently low, they can be connected to either the filament or plate circuit.

In connection with the pressure testing of transformers, the testing transformer should be fed preferably from a variable-speed alternator, to give the desired frequency, with its field excited from an exciter on the same shaft, itself excited from an independent and constant supply, such as a battery. This requirement is to ensure as far as possible a constant voltage.

The arrangement of the test is shown in Fig. 4, and the procedure is similar to that already described for over-potential testing. With this type of test the spark gap is used as a measure of test voltage, and the crest voltmeter as an indication that the voltage has been reached when the gap is disconnected. A voltmeter is also used across the low-tension windings of the testing transformer calibrated in high-tension volts, and the reading recorded on this meter gives, when compared with the test voltage, a measure of the increase in voltage due to the capacity of

the transformer under test. An ammeter inserted in the low-tension winding of the testing transformer will give a measure of the load, and any fluctuations in the reading during the test will give an indication of creepage. It is recommended that before the testing transformer is connected to the transformer under test, the crest voltmeter be calibrated with the spark gap for each test voltage required, and that during the test the spark gap be cut out, thus eliminating possible surges due to the breakdown of the gap.

Multiple Flap Valve.

WHEN pumping sewage with displacement pumps, the necessity of having large flap valves so that the solids may pass freely, has been a difficulty in the way of employing such high piston speeds as are possible with multiple valves when dealing with clear water. To meet this difficulty what is known as the "Ismailia" valve was designed and patented by Mr. E. C. Bowden-Smith, of 17, Victoria-street, London, S.W. 1.

The valve derives its name from the fact that it was first used at the Ismailia Pumping Station at Cairo, in connection with pumps designed to discharge crude sewage against a head of 300ft. It is often possible, the inventor states, to increase the speed and discharge of a pump by substituting multiple valves of this type for valves of large area, and, in that way, to avoid the installation of an additional unit in the event of it becoming necessary to increase the capacity of a pumping station.

The general design of the "Ismailia" valve will be understood from Fig. 1, which shows it applied to a stoneware pipe, and it is claimed for it that, not only does it provide a clear way for the passage of the liquid and is free to seat evenly, but it has no hinge to collect fibrous matter, and possesses the advantage that it can be removed and replaced by hand without the use of tools.

Owing to the large quantities of grit which some sewages contain, provision has to be made for periodically removing and refacing the valves, and it is asserted that, with the type of valve under consideration, the work of replacement can be carried out much more quickly than is possible with hinged flap valves—in fact, in hours instead of days, or, with small pumps, in minutes instead of hours. It is explained that this celerity is made possible because, instead of having to unscrew corroded nuts and to knock out refractory pins, it is only necessary to keep the front of the valve depressed and then, by a slight motion, to withdraw it from the guides. We are assured, however, that, in spite of the ease with which withdrawal can be effected, the liquid passing through the valve cannot impart the motion necessary to dislodge the valve, nor can the latter become accidentally disengaged.

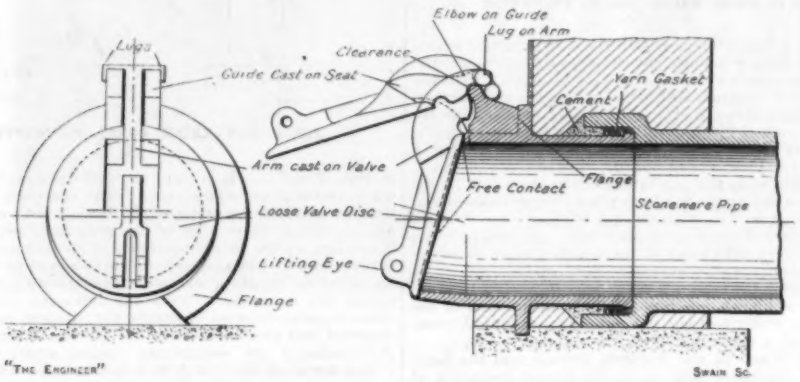


FIG. 1—THE "ISMAILIA" VALVE APPLIED TO A STONEWARE PIPE

As an example of how the employment of these valves makes it possible to design frames of great strength and large dimensions, Mr. Bowden-Smith has sent us a photograph which is reproduced in Fig. 2. The valve frames or plates illustrated measure 7ft. 9½in. by 4ft. approximately, and weigh 2 tons. They contain seventy valves, each 4¾in. by 4¾in., with a total area of 1340 square inches. In the particular example shown the frames and valve sets are of cast iron in one piece. The stops which form the guides for the valves are of cast steel, and are secured in place by studs. The valves themselves, which drop into place under the action of gravity, are of cast steel with leather facings.

Four of these frames are fitted, one on the suction and one on the delivery, to two pumps, which have been manufactured by Worthington-Simpson, Ltd., of London, for the Municipality of Bombay, the frames and valves complete having also been made by the same firm to the designs of the patentee. The pumps are single-acting, with rams 38½in. diameter and a 72in. stroke, and they are each designed for a maximum discharge of 15,000,000 gallons per day. They are driven by compound rotary beam engines with cylinders 23in. and 38in. in diameter and strokes of 33in. and 57in. respectively.

The inventor further points out that, for reflux valves, the "Ismailia" flap permits of the use of multiple doors without hinges, and a diaphragm and casing of great strength, but of light design, and that it is possible to employ simply a manhole in place of a massive cover for inspection and replacements. We understand that valves of this type are in use not only for pumps and reflux valves, but also for tidal flaps, and, when operated by a chain or rod, as wash-out valves for reservoirs, as flushing valves for sewers, as discharge valves for cisterns, and for many other purposes.

Finally, it is claimed by Mr. Bowden-Smith that, by dispensing with a hinge, his design introduces a new principle into valve construction, which is of great value and possesses outstanding advantages, since it provides a clear way, and is "free" to seat evenly, being, therefore, perfectly watertight, and, since it eliminates—in single valves—the use of nuts, bolts, screw threads, and fastenings of every description. There is, he adds, nothing to work loose, nothing to come adrift, and nothing to rust away. It consists literally of two interlocked castings.

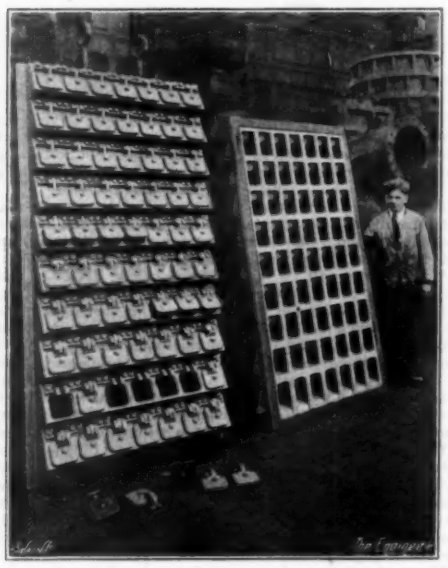


FIG. 2—"ISMAILIA" VALVE PLATES FOR BOMBAY

Books of Reference.

THE twenty-eighth edition of "The Practical Electrician's Pocket Book," which is published by S. Rentell and Co., Ltd., of 36, Maiden-lane, Strand, London, W.C. 2, price 3s. net, has just appeared. We are informed in its Preface that it contains many important alterations and improvements. The sections dealing with "Direct-current Generators and Motors," "Alternatic-current Theory," and "Alternating-current Generators," have been entirely rewritten at considerably greater length, while the sections on "Motor Generators" and "Transformers" have been revised and partly rewritten. There are three new chapters, entitled respectively "Power Factor Correction," "Localisation of Cable Faults," and "Alternative Current Protective Systems." The chapter on "Electricity in Coal Mines" has been rewritten to bring it up to date, and the sections dealing with "Illumination" and "Electric Lamps" have been revised. Developments in connection with wireless broadcasting are so frequent nowadays that it is not surprising that the section allotted to it has been overhauled and revised.

"THE *Mechanical World* Electrical Pocket Book," which is published by Emmott and Co., Ltd., of 65, King-street, Manchester, price 1s. 6d., appears in its 1926 form in the nineteenth year of publication, and it contains many new features, among which may be mentioned a section on "Jointing Conductors," and another which deals with "Magnetic Chucks" and "Magnetic Clutches." Another section on "Industrial Applications of Electro-Chemistry" gives information concerning the most recent advances in the electro-deposition of metals and various electrolytic and analogous processes. Other new sections are those on "Industrial Electric Heating" and on "Cutting by the Electric Arc." There is also a section dealing with "Depreciation," while the section on "Electric Hoists" has been replaced by a new and more extensive section on "Electric Lifts, Cranes, &c." Other sections have been revised where necessary, and many new illustrations have been added.

The Ice and Cold Storage Trades Directory, 1926, is obtainable from Iliffe and Sons, Ltd., Dorset House, Tudor-street, London, E.C. 4, price 10s. 6d. The present edition, which is the twentieth, has, we are informed, been carefully revised and brought up to date, and several hundred new names have been added to the alphabetical and classified trades sections. Furthermore, the increasing application of refrigeration in nearly every branch of trade has necessitated the inclusion of several more headings in the last-named section. As usual, the front portion of the volume is devoted to tables, many of which contain data which are not readily obtainable in so compact a form elsewhere, and, in addition, details are given of the patents relating to refrigeration which have been granted since the last edition was published, as well as a list of new companies, the articles of association of which include refrigeration, that have been registered during the same period.

"*Mechanical World*" *Year Book*. Manchester Emmott and Co., 1926. 1s. 6d. net.—The "*Mechanical World* Year Book," which is now in its thirty-ninth year of publication, needs little recommendation to engineers, as it is probably, considering its price, one of the most popular books of reference of its kind. The present issue has been extended slightly by the addition of new sections dealing with the uniflow steam engine, grinding and the allowances associated therewith, forced and shrinkage fits, and chains and ropes for lifting. The section on superheating has been re-written, and a new part concerned with fuel economisers has been introduced. The book now contains nearly 350 pages of directly informative matter besides the indices and advertisements.

The "Practical Engineer" Electrical Pocket Book and Diary, which is obtainable from Mr. Humphrey Milford, the Oxford University Press, Falcon-square, London, E.C. 4, appears, in its 1926 edition, in its twenty-seventh year of issue. In the preface we are informed that several sections have been revised, so as to bring them thoroughly up to date, particularly that on Switchgear and Circuits. Otherwise the volume appears to be unchanged, and it will doubtless be found as useful as those which have gone before it. It is published at two prices: 2s. 6d. net with cloth binding, and 3s. net with Pluviusine binding.

THE BOND BETWEEN CONCRETE AND STEEL.

WE have recently received a copy of a small book, entitled "Studies of Bond between Concrete and Steel," which forms Bulletin 17 of the Structural Materials Research Laboratory, Lewis Institute, Chicago. The author of the subject matter is Mr. Duff A. Abrams, who is the professor in charge of the laboratory, and the report is reprinted from the 1925 "Proceedings" of the American Society for Testing Materials.

It appears that, in the investigations reported on, the bond tests were made by applying a pull on one end of 1in. plain round steel bars embedded axially in 8in. by 8in. concrete cylinders; while parallel compression tests were made on 6in. by 12in. concrete cylinders. The concrete covered a wide range in quantity of mixing water, cement and size and grading of aggregate. Tests were made at ages of seven days to one year; 735 pull-out bond tests and 735 parallel compression tests were made.

The principal conclusions from the tests were:—

(1) Slipping of the bar began at a bond stress of about 10 to 15 per cent. of the compressive strength of the concrete, but considerable additional load was taken before the ultimate bond resistance was reached.

(2) An end slip of bar of 0·0005in. occurred at 55 to 60 per cent. of the maximum bond. For mixtures leaner than 1–1, the maximum bond was about 24 per cent. of the compressive strength of the concrete and came at an end slip of about 0·01in. regardless of the characteristics of the concrete.

(3) Bond and compressive strength increased with age of the concrete from seven days to one year. For 1–5 concrete of water ratio 0·88, the bond at one year was 134 per cent. of the twenty-eight-day value and the compressive strength was 148 per cent.

(4) Bond responded to changes in water ratio of the concrete in much the same way as compressive strength; increase in water ratio due to use of wetter concrete, less cement or an excess of fine aggregate, resulted in material reductions in both bond and compressive strength.

(5) For mixtures richer than 1–1 the bond fell off, probably owing to the greater volume changes during hardening, which is characteristic of such mixtures.

(6) The use of 4 per cent. of the twenty-eight-day compressive strength of concrete as the working stress in bond for plain bars, as specified by the Joint Committee, is justified. This gives a factor of safety of about 2½ to 3 against first slip.

(7) The use of crude oil to replace mixing water, in general, caused a reduction in both bond and compressive strength of concrete due probably to the lubricating effect of the oil. Replacing cement with hydrated lime also decreased the compressive strength and bond about 1·2 per cent. for each 1 per cent. of hydrated lime, in terms of volume of cement, or about 2 per cent. for each 1 per cent. by weight.

REFLECTOR FITTINGS FOR ELECTRIC LIGHTING.

THE Sectional Illumination Committee of the British Engineering Standards Association has just completed a specification for industrial reflector fittings for electric lighting (No. 1)—No. 1, Open Dispersive (Vitreous Enamel) Type for Direct General Lighting for use with Gas-filled Electric Lamps complying with the requirements of B.E.S.A. Specification No. 161—1924. The specification covers seven sizes of British industrial circular reflector fittings, which are designated according to the nominal consumption of the lamps for which each is suitable, and the distribution of light contemplated is suitable for use in installations in which the spacing of the lamps is 1½ times the height. A comprehensive table gives the nominal diameter, the minimum effective interior diameter, the minimum thickness of steel used for making the reflector fitting and particulars of suitable lamps

complying with B.E.S.A. Specification No. 161—1924, for each size of reflector fitting.

The angle of cut-off specified complies with the recommendation contained in the second report of the Departmental Committee on Lighting in Factories and Workshops, 1921, but attention is drawn to the fact that this figure may be altered at a later date when the results of certain experiments which are being carried out are available. The total luminous output is given as 60 per cent., but it is pointed out that an efficiency of about 70 per cent. was obtained with this type of reflector under the conditions which were usual formerly. The conditions have been altered as mentioned above in order to reduce the amount of glare and so comply with the recommendations of the Departmental Committee. Methods of selection for testing and of efficiency measurement are also given in the specification. Copies of the new specification (No. 232—1926) may be obtained from the B.E.S.A. Publications Department, 28, Victoria-street, London, S.W. 1, price 1s. 2d. post free.

South African Engineering Notes.

Factories in Liquidation.

There appears to be a marked desire—which is certainly fostered by the Government—to make the Union of South Africa a great manufacturing country. All sorts of different industries are being started, and in each case it is announced that success is assured. The facts that the white population of the country, which is the only large consuming element, numbers but a million and a-half all told, and that the prospects of building up an export trade are practically nil, do not seem to be given any consideration. At the moment there are four large concerns in liquidation at the same time. One factory, which was erected for the making of sulphate of ammonia has been closed down. The huge plant and property, costing well over £500,000, has been placed in liquidation, and the liquidator has decided to dispose of the assets in whole or in part to the highest bidder. Enormous quantities of coal, machinery, structural steel, railway material, stores, piping, buildings, scrap lead, copper and brass are to be disposed of. Then, again, a large paper mills has come to grief, and tenders are invited for the purchase of the machinery, plant, and building, as a going concern. The plant includes an up-to-date Fourdrinier machine, capable of making 150 tons of paper per month, with boilers and engines, also a large tube bag machine for making brown paper bags. A woollen firm is also in liquidation, and its factory, together with all other assets, which include, in addition to the buildings, fixtures and fittings, plant and machinery contained therein, including 60 looms; 20 Jacquard looms stored in Hamburg, Germany, &c., are for sale. The majority of the woollen factories erected out here seem to favour German machinery, owing to its being supplied at a so much lower price than English machines—and sometimes German managers and technical staffs, &c., but, so far, their success has not been startling. The fourth liquidation is that of a bacon factory. In this case, of course, the industry is a legitimate one, as there should be an assured market; but, unfortunately, it would seem that the bacon produced could not compete with that of the imported article.

The Kalahari Problem.

As already reported in these notes, a survey party was dispatched in July last by the Irrigation Department of the Union Government to survey the lake region of the Kalahari, and to test the feasibility of Professor Schwarz's project, which aims, by erecting dams at suitable points, to obtain sufficient water from the Chobe and Okavango Rivers to fill the Makarikari depression, and thus create a lake 15,000 square miles. The idea is to restore the old conditions under which the Kalahari was a region of very considerable fertility. The expedition is now returning, and the last official news from it dealt with its operations along the Suvuti River to its junction with the Linyati River. Levelling operations had reached the junction of the two rivers and, having achieved one of the main objects of the survey, the party proceeded to carry on a line of levels southwards from its base camp on the Suvuti River, some 20 miles south of Goba Hill. The levelling continued southwards from this point along the Mababe Depression into the valley of the Mogogelo River, and then along the Tamalukane River as far as Maun, a distance of some 160 miles. The Tamalukane River is one of the rivers of the Okavango River system, and it will be realised therefore that the party has made good progress in its investigations of an objective of great importance, namely, the determination of the relationship between the Zambesi River system and the Okavango River system. According to the latest official bulletin, the Okavango River system was carrying a considerably greater flow of water than had been known for some time, and that for the first time for fifteen years, the branch of the Botletle River, known as the Ngami River, was flowing into Lake Ngami. While in the neighbourhood of Lake Ngami and Maun, the reconnaisance party took advantage of the opportunities for taking cross sections and gauging at important sites on a few rivers. Observations were taken of the Botletle River just below its junction with the Tamalukane and Ngami Rivers. Similar measurements were taken of the latter river, as also of the Kunyere River, a feeder flowing into Lake Ngami. The party has started on its return journey, and will, to a large extent, retrace its steps, but will make deviations at certain points in order to investigate regions which deserve special attention. It will also make detailed surveys of certain areas which investigations to date have shown to be of paramount importance, especially localities which give evidence of being possible suitable dam sites.

Port Elizabeth's Electrical Power.

The Municipality of Port Elizabeth has just added a new 3000-kilowatt turbo-alternator at its North end electricity works. This set brings the capacity of the station up to 9500 kilowatts, and the present annual output varies between 7,000,000 and 8,000,000 units. The new generating set was supplied by C. A. Parsons and Co., Ltd.

Mineral Output.

The value of the Union's mineral output for November was £4,486,371, the acute shortage of native labour having adversely affected the working of the mines. For the eleven months ended November 30th, 1925, the total value of the mineral output was £49,795,156, as against £53,190,436 for the same period of 1924. The decrease is almost entirely due to the disappearance of the gold premium, consequent upon the return of Great Britain and the Union of South Africa to a gold basis. The value of the gold for 1925 was £37,450,203, compared with £40,929,644 in 1924. The other principal items are:—Diamonds, £7,485,749; coal, £3,562,753; copper, £452,834; and tin, £273,349. The quantity of osmiridium recovered by gold mines on the Rand continues to increase, the value for the eleven months of 1925 being £162,263, against £94,938 for 1924.

Witbank Super Power Station.

Barren veld less than eighteen months ago, a large area of land outside Witbank is now a hive of industry round a gigantic steel structure, which is to house the largest electrical generating station in South Africa. The station, which will be owned by the Electricity Supply Commission, will contain three 20,000-kilowatt sets, with room for the introduction of two other sets, equal to a total capacity of 100,000 kilowatts. The current from the station will be sent out at a pressure of 132,000 volts along 65 miles of overhead transmission conductors to the Brakpan Station, one of the units of the Rand supply system. It is hoped to have one of the sets in operation in a few months time. Twelve Babcock and Wilcox boilers will be required to provide steam for all the turbines, and efforts are now being concentrated on completing sufficient to run the one set. The boilers are to burn the very lowest grade of coal, the dust and very fine coal which, for normal industrial purposes has no market.

Union Irrigation.

South Africa is well off in many districts with modern water supply and irrigation schemes, and everything points to the fact that greater developments will take place in 1926. There are many large schemes being prepared. The further development of South Africa by irrigation is engaging the attention of the Union Parliament and, according to statements in official circles, a new Bill is being prepared, which will initiate an attempt to set up a permanent Commission, possessing wide powers similar to those of the Electricity Commission and Railway Board. Though some important schemes for the irrigation of certain sections of the Union were completed in 1925, there still remains a great amount of work to be done, apart from the routine work in which the Irrigation Department is engaged, such as the completion of the Hartebeestpoort Canals and survey work. Along the Vaal River, for instance, possible schemes will have to be considered. But the Commission, no doubt, will take up these and other projected works when the members of it are selected. The Bill, it is understood, will be a far-reaching measure. Up to the present, the Union Government has invested £4,000,000 in irrigation schemes, some of which are not paying, and a determined effort will be made to recast and develop the existing system and policy of irrigating the land.

Broken Hill Power Scheme.

The Mulungushi Power Station, situated far to the North of the Victoria Falls and close to the borders of the Belgian Congo, was recently completed. The undertaking was determined upon in consequence of the necessity for adopting the electrolytic process for the extraction of zinc from the ores contained in the mining property of the Rhodesia Broken Hil Development Company, Ltd. The ores are of considerable variety, but the economic metallic elements contained are lead, zinc, silver and vanadium. Previously, production had been confined to lead bullion—*i.e.*, pig lead containing silver—while the residues, containing a high proportion of zinc, had been allowed to accumulate pending the establishment of the best method of treatment. Experiment showed that the best results could be obtained by an electrolytic process, the zinc thus produced being of exceptional purity and commanding a premium on the market on that account. Investigation showed that an adequate supply of water power could be developed on the Mulungushi River, but the river being subject to extreme variation, falling as low as four cusecs toward the end of the dry season, it was necessary to provide storage of large capacity. A suitable site for a reservoir was available within a short distance of the falls, where the river had cut a narrow passage through a range of hills. By closing this gorge with a dam rising to 160ft. above the lowest level of the river bed in the gorge, it was possible to create an artificial lake sufficient, it is calculated, to insure a continuous output of 20,000 kilowatts. This work has now been carried out, throwing back the waters of the river no less than 20 miles and forming a lake with a maximum width of 5 miles, containing over 6000 million cubic feet of water. The lake is served by a catchment area of over 1700 square miles, with a mean annual rainfall over the last fifteen years of 35in. The flow of the river during construction was taken through a tunnel driven 525ft. through the solid rock of the hill to one side of the dam, and the same tunnel is now used to pass the water from the dam to the conduit leading to the power stations, the discharge being controlled from two steel towers 5ft. in diameter, and rising 95ft. above their concrete bases. There is a service reservoir about a mile downstream, and a canal 13,000ft. long, cut along the hillside, with reinforced concrete fluming laid across intervening gullies, leads from it to a forebay above the station. The gradient is 1 in 2500, and the section is adequate for the development of 10,000 kilowatts. The canal terminates in a concrete lined forebay, 120ft. long by 40ft. wide, divided into three compartments, from each of which a penstock will be led down the hill to the station. At present one penstock only, supplying a 2500-kilowatt set, is installed. The other two will be laid presently. The design and execution of the scheme were the work of the consulting engineer of the Central Mining and Investment Corporation, and the work was under the personal supervision of Mr. W. Elsdon Dew, M. Inst. C.E.

Union Rolling Stock.

Since Union 1910 up to December 31st. 1924, 722 engines, 1287 coaches, and 12,960 goods vehicles had been placed in service on the railways of the Union of South Africa. Between January 1st, 1925, up to October 10th, 1925, 38 engines, 25 coaches and 509 new goods vehicles had been placed in service. There were then shipped, under construction, on order, or tenders invited for, 35 new engines, 501 new coaches and 1133 new goods vehicles. In addition to the 35 steam locomotives authorised, an order had also been placed with the Metropolitan-Vickers Electrical Company for seventeen combined passenger and freight electrical locomotives with spares, of a value exceeding £250,000. During August last 130 locomotives and 1722 goods vehicles were repaired in the Administration's workshops, compared with 122 locomotives and 1640 goods vehicles during the corresponding month of 1924. The percentage of engines out of traffic and waiting repair was reduced from 23.8 at March 31st, 1922, to 18.7 at February 28th last, and to 16.3 at October 10th, 1925. The similar percentages of goods stock out of commission were 5.4, 4.93, and 3.38.

The Institution of Civil Engineers.

OCTOBER EXAMINATIONS, 1925.

PASS LIST.

Preliminary (61).—W. J. Andrews, W. G. Beeson, J. E. Bentley, A. T. Black, G. C. A. Bryan, H. A. F. Canfield, A. E. Clark, C. Clark, G. H. Clegg, H. C. Davey, J. D. Deane, I. A. Dubery, H. H. Evans, J. D. Fidler, G. Gale, H. J. V. Glenday, A. E. Hagelstrom, S. S. Harrison, D'A. O. Haskell, R. M. Hayes, C. T. Henfrey, F. Hewson, H. J. Hill, G. Hodge, J. D. How, A. D. Hughes, A. H. F. Jiggens, W. F. Longfield, I. Macallan, S. M. Outan, A. G. Park, H. V. Phillips, A. A. Ragg, R. S. Rendle, J. R. S. Rhodes, J. P. Richards, F. K. Roberts, R. A. Russell, F. C. Sage, J. A. T. Shannon, F. A. Shorter, G. Shrimpton, E. L. Simpson, J. M. Simpson, G. Slater, E. F. Smith, F. A. Smith, L. J. G. Smith, P. M. Spencer, J. F. G. Spring, G. T. Starling, E. E. Sweeting, H. H. N. Thompson, E. J. Tonelli, N. Whear, W. R. White, C. I. Wilks, R. J. Willy, E. Wood, F. T. Wood, F. R. Wright.

Associate Membership (234).—Whole Examination (Sections A, B and C (18).—T. A. Adams, E. M. Austen, H. Cliffe, W. Dixon, J. Dove, D. F. Hulse, W. A. Ingham, G. W. B. Lowson W. E. Lucy, K. B. Robinson, H. V. Smith, H. G. Stevens, A. C. Swanson, A. H. E. Tippett, L. Tulley, L. E. R. Wakeman, R. A. Westwood, W. H. Whitehouse.

Sections A and B only (24).—J. A. D. Anderson, E. H. Bacchus, R. C. Bond, A. B. Bremner, W. E. Bulman, P. Burgoyne, R. E. Downes-Shaw, I. Evans, C. W. Firth, J. G. Gardiner W. J. E. V. Grace, W. F. Gray, J. E. Gregory, G. H. Hadden, J. F. Hand, W. M. Laird, G. J. Mair, J. D. Midforth, J. F. H. Nicholson, J. W. Pallister, D. S. Parmara, J. L. Raeburn, J. A. Welch, A. G. Wheeler.

Sections A and C only (4).—J. F. Darnborough, F. F. Hixson, E. G. McLeod, G. Perry.

Sections B and C only (15).—C. F. Chambers, R. M. Drynan, H. Eaves, A. R. Entrican, T. C. S. Haslam, W. A. Knighton, A. L. Linford, W. J. Litherland, P. V. Marchant, J. Penman, A. M. Rosie, jun., N. L. Samson, W. S. Visick, D. R. Williamson, T. M. Wright.

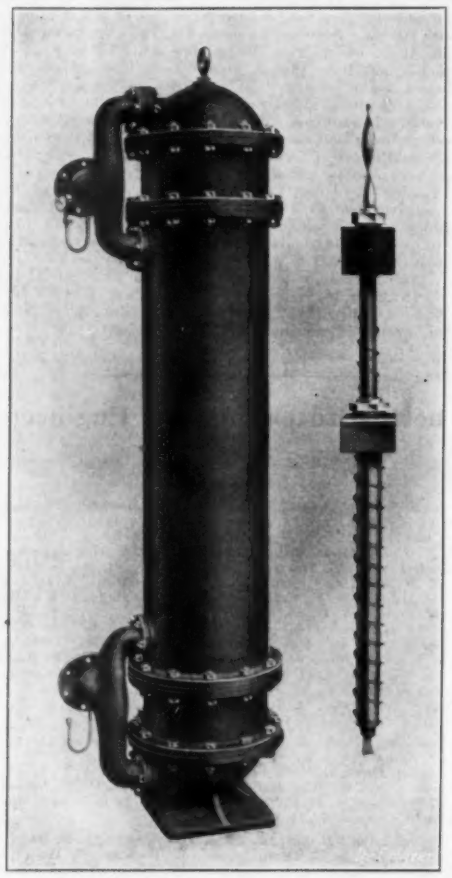
Section A only (46).—A. Adlington, R. A. T. Anderson, D. B. Bald, L. Bendelow, H. W. Cameron, N. R. Carter, G. H. H. Collins, C. C. Cunnold, E. J. Davies, J. N. Deason, T. S. B. Dick, A. R. Dippie, H. D. Drummond, A. H. Eaton, C. B. Eck, W. H. French, G. H. Fretwell, R. W. Hall, D. Harry, H. Haughton, The Hon. G. A. R. Hay, H. S. Heath, W. Hood, G. Howell, N. H. Hunt, E. Hutton, W. B. Instone, N. Jervis, H. V. Langley, G. S. Lindsay, S. E. Lineham, D. Melville, L. F. Nicholson, W. K. M. O'Hara, M. W. G. Overton, A. L. Owen, N. L. Paterson, L. W. Rogers, P. H. Selbie, R. G. Slyfield, W. Struthers, G. W. Warr, J. S. Whyte, J. W. Wilkinson, T. Willey, H. Wolf.

Section B only (28).—R. L. Clack, R. Crooks, R. S. E. B. Hart-Davies, J. Y. Hughes, C. S. Jackson, A. C. M. Jansen, J. Kirby, J. P. Larkin, J. McAdam, R. MacDonald, G. W. Nash, H. Neal, A. C. Page, F. L. Pasley, R. Pearce, T. Porter, E. J. C. Reed, L. Reeves, W. A. R. Robertson, E. W. Russell, S. G. Squires, I. H. Strachan, W. K. Taylor, A. G. Ticehurst, F. W. D. Timson, F. W. Waddell, B. E. B. Walker, J. Walker.

Section C only (99).—T. G. G. Beck, T. Bell, K. G. Benham, C. W. E. Bishop, B.Sc. Eng. (Lond.), E. F. Blackbourn, K. P. Brow, P. B. Bryden, F. T. Bunclark, B.Sc. Eng. (Lond.), F. W. Butler, B.Sc. Eng. (Lond.), W. Butterworth, J. G. Campbell, J. S. Carmichael, J. A. Chippindale, L. Cleaver, B.Sc. (Wales), N. Cobein, W. P. S. Cockle, B.Sc. Eng. (Lond.), D. K. A. Coe, B.Sc. Eng. (Lond.), E. C. Cookson, B.Sc. Eng. (Lond.), H. L. Copestake, N. Davey, B.Sc. Eng. (Lond.), C. G. Day, A. Dean, M.Sc. Eng (Lond.), K. L. Forster, C. E. Gayes, M.Sc. (Leeds), O. W. Gilmour, B.A.I. (Dublin), W. H. Glanville, B.Sc. Eng. (Lond.), S. E. Golledge, G. S. S. Gordon, B.A. (Cantab.), G. I. B. Gowring, B.Sc. Eng. (Lond.), A. P. Grant, B.E. (New Zealand), H. J. B. Harding, B.Sc. Eng. (Lond.), A. L. Harvey, M.C., B.A. (Cantab.), P. C. G. Hausser, B.Sc. Eng. (Lond.), C. H. McL. Hawk, L. E. Hawkins, B.Sc. Eng. (Lond.), T. E. Hawksley, B.A. (Cantab.), W. H. Hillier, M.Eng. (Sheffield), B. Hodgson, J. L. Hunt, B.Sc. Eng. (Lond.), B. W. Huntsman, B.Sc Eng. (Lond.), B. H. Johnson, B.A. (Cantab.), V. D. Joll, B.Sc. (Bristol), J. C. Jones, B.Sc. Eng. (Lond.), L. E. Jones, J. Kennard, B.Sc. Eng. (Lond.), R. P. Key, B.Sc. (Leeds), C. I. Kidson, B.E. (New Zealand), F. X. Koenig, E. B. J. Lanyon, H. F. Lee, E. G. Lee, B.Sc. Eng. (Lond.), W. G. Lees, B.Sc. (Birmingham), C. G. Lomax, D. C. Luck, E. R. McKillop, D. S. G. Marchbanks, D. E. S. Mason, S. H. Medcalf, B.A., B.A.I. (Dublin), K. G. H. Montgomery-Smith, B.Sc. Eng. (Lond.), C. C. Morley, B.Sc. (Birmingham), T. P. de S. Munasinghe, A. N. Myles, B.Sc. Eng. (Lond.), H. A. W. O'Connor, J. F. Pain, M.C., B.Sc. Eng. (Lond.), T. J. Palmer, B.E. (New Zealand), A. Peel, B.Sc. (Leeds), E. B. S. Powell, R. W. R. Powrie, B.Sc. (Edin.), W. E. Puddy, H. Pughe-Evans, B.A. (Cantab.), W. E. Reed, G. J. Richardson, E. H. Sale, B.A. (Cantab.), J. Sewell, N. Shand, B.Sc. (Cape), A. B. Sharp, jun., H. C. Sharpe, H. M. Sherrard, B.C.E. (Melbourne), L. Singh, W. Sleight, B.Sc. (Leeds), H. L. Smith, A. Spence, W. R. G. Taylor, G. H. Todd, C. B. Townend, B.Sc. Eng. (Lond.), B. G. Tweyross, B.A. (Oxon), W. Urquhart, B.Sc. (Edin.), J. Verity, F. W. F. Waitt, B.C.E. (Melbourne), G. R. Walter, J. D. Watson, B.Sc. Eng. (Lond.), A. C. Webber, R. E. P. Wheatley, B.A., B.A.I. (Dublin), L. C. Whiskin, E. H. Wild, C. R. Wood, B.A. (Cantab.), A. Woodburn, jun., R. M. Wynn-Edwards, D.S O., M.C., B.A. (Oxon), H. Zaky, B.Sc. (Birmingham).

A New Oil Cooler.

We give in the accompanying engravings illustrations of a new form of cooling apparatus which is being placed upon the market by the Reliance Manufacturing Company (Broughton), Ltd., of Lower Broughton, Manchester.



RELIANCE FLUID-COOLING APPARATUS

Although this cooler was designed primarily for dealing with lubricating oil, it is, of course, equally applicable to other liquids or gases, and may, by reversing its action, be utilised as a heating apparatus. The cooling surface is provided by a battery of tubular elements, each of which comprises an inner and an outer solid-drawn tube through the annular space between which the oil or other liquid has to pass, while the cooling medium is passed through the inner tube, as well as circulating round the outer tube. Round the outside of the inner tube is placed a wire helix of a gauge sufficiently large to fill the intervening space between the two tubes and cause the liquid being cooled to take a helical path in a ribbon form downwards. Other coils or helices are placed round the outer circumference of the larger tubes, while inside the smaller tubes a spirally twisted strip of loose metal extends from the top to the bottom of the apparatus in order to give a whirling motion to the cooling water in its passage through the tubes. The body of the cooler is composed of five parts, a main cylindrical portion C, with inlet and outlet branches, for the cooling water, and flanged ends to which tube plates are secured; above and below this main body are cylindrical chambers for the oil or other liquid which is introduced at the top and passes out at the bottom as shown, and to these oil chambers again are fitted semi-circular shaped covers forming inlet and outlet chambers for the water, which passes through the inside of the small tubes. Hand holes are provided in each of the sections for cleaning purposes, and it is possible by these means for the attendant to move the wire helices up and down the tubes, and thus remove from them any deposit. In order to permit of expansion and contraction of the tubes, owing to changes of temperature, gromet joints are provided for the tubes where they pass through the tube plates, as shown in the detail view of the tubular element.

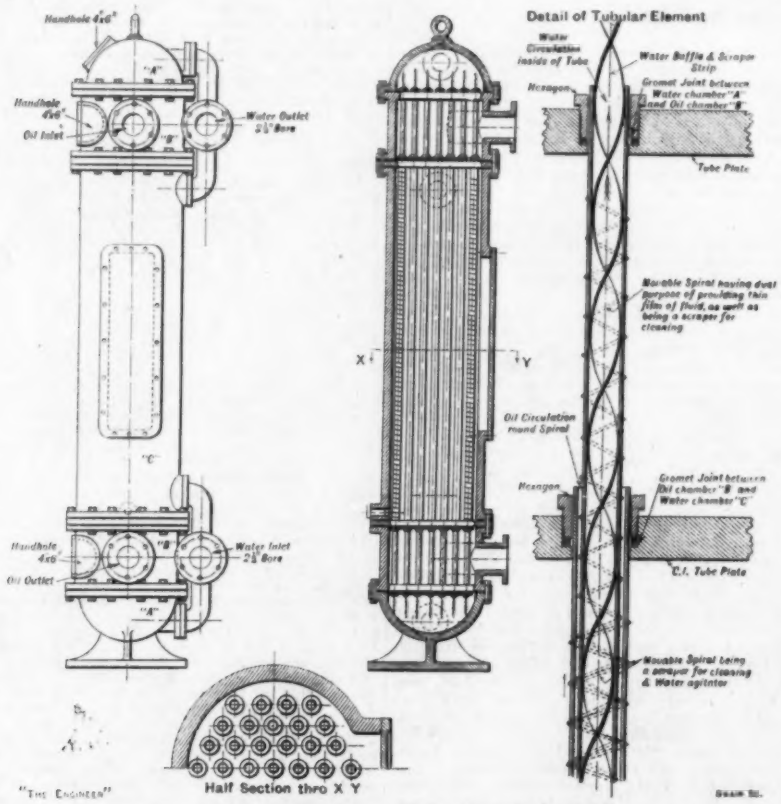
The resistance to the flow of the liquid through the apparatus is almost negligible, and can be readily regulated by altering the gauge of the wire which forms the helical pathway. As only a thin film is exposed to the maximum cooling surface at high velocity, the factor of conductivity is high.

One of these coolers with a capacity of 40 gallons of oil and 40 gallons of water per minute has been tested in the laboratory of L. Gardner and Sons, Ltd., Patricroft, and the following are some of the results obtained :—

	Temperatures in degrees Fah.				
Oil entry	140	130	120	110	100
Oil exit	116	108	101	94	87
Fall	24	22	19	16	13
Water entry	50	50	50	50	50
Water exit	60	59	58	57	56
Rise	10	9	8	7	6

	Heat extraction.			
B.Th.U. per min.	4080	3740	3230	2720	2210

The weight of the cooler was 8 cwt.



ARRANGEMENT OF RELIANCE FLUID-COOLING APPARATUS

American Engineering News.

DIESEL-ELECTRIC DREDGER.

For excavating sand and gravel from the bed of the Ohio River, a company at Pittsburg is using a large ladder dredger operated by an oil-electric unit, as the water is so fouled by discharges from steel works and other industries that it is not fit for boiler use. The dredger, with a dead-weight of 900 tons, has a four-cylinder two-cycle solid injection Diesel engine of 300 horse-power, directly connected to a Westinghouse 270 kilovolt-ampère, 60-cycle, three-phase, 440-volt generator, which supplies current for the several motors operating the machinery. The ladder, in the centre line of the hull, has its head suspended by cables from a heavy inclined frame at the bow. This ladder is 95ft. long, and may be suspended at an angle of 45 deg. for a maximum digging depth of 50ft. The buckets, spaced close together, are of 8 cubic feet capacity, each being a casting of nickel-chrome steel with a manganese steel lip. The weight of the ladder, with chain and buckets complete, is about 110 tons. The dredged material is delivered to a hopper which feeds a revolving screen, 7ft. in diameter and 32ft. long, with an outside jacket or sand screen, 8½ft. diameter and 16ft. long. The several sizes or grades of sand are spouted to bins on one side and the gravel to bins on the other side. Elevating conveyors take the materials from the bins and carry them up to the heads of long inclined spouts which deliver the materials to steel barges of 700 tons capacity. A barge with a 15,000-gallon tank supplies oil to a 7000-gallon tank on the dredger, the engine having its own pump to take oil from this tank.

UNDERGROUND MINING OF LIMESTONE.

At the original quarry of the White Lime Company, in Missouri, the depth of overburden became too great for economical removal, and the stone is now obtained from underground workings. As the total distance from the kilns is about 1200ft., and includes gradients of 1 in 25, the mine wagons are operated by petrol locomotives. Two qualities or grades of stone are encountered, and are handled separately. The first headings are 40ft. wide and 16ft. high, with complete removal of a first-class oolitic limestone, which is burned in kilns operated exclusively for this stone, and producing high-chemical lime. Above this is a 4ft. bed of an inferior limestone, which is drilled from the first heading by stoping machines and is shot down on the mine tracks for removal. Finally, a third layer of about 25ft. is removed by drilling holes 21ft. and 24ft. deep, leaving a good roof or parting. Above this is solid rock of an impure quality, not suitable for lime burning. The only defect in this roof is the occasional existence of wide cracks or seams. To prevent mud and gravel from falling through in wet weather, these cracks are sealed by planks laid across old rails attached to expansion bolts. A later step will be a 15ft. cut in the floor, leaving a stope 60ft. high, and getting out 86 per cent. of the available stone. Eventually the pillars will be robbed.

CREOSOTING WORKS OF THE SOUTHERN PACIFIC RAILWAY.

The new plant built by the Southern Pacific Company, at West Oakland, provides for the treatment of ties or sleepers, piles and bridge timbers. Sleepers are treated by the Rueping process, with a mixture of 70 per cent. creosote and 30 per cent. asphaltic-base petroleum, giving a retention of 7 lb. of creosote per cubic foot. Piles are treated to saturation with pure creosote to insure maximum protection against the boring insects in sea water. For several years the zinc-chloride process was used for the sleepers, but it has now been abandoned in favour of creosoting. The company has now four plants, with an aggregate capacity of 2,700,000 sleepers per year. At the new Oakland plant the sleepers pass through a wood-working mill before going to the retorts, this mill having a capacity of eight sleepers per minute. Here the eight holes are bored for the spikes, a thin slice is sawed from each end, and the sleeper is branded with marks indicating the year of treatment, the preservative used, and the rail section for which it is bored. It is also passed between toothed rollers which make incisions in the surface to facilitate the penetration of the oil in such dense woods as Douglas fir. The two retorts are 8ft. in diameter and 133ft. long, with the unusual feature of standard gauge instead of narrow-gauge tracks for the tramcars on which the sleepers are loaded. Trains of these cars are handled by petrol locomotives. For the butt treatment of telegraph and telephone poles there is a treating vat in which the poles are stood in an 8ft. depth of creosote.

PROGRESS AND HAPPINESS.

The following passage is taken from an address delivered by Professor A. E. Kennelly, of Harvard University, to the American Association for the Advancement of Science in December last :—

"The advances of science and of engineering have thus far always enriched mankind materially. Material production has been greatly hastened; so that the average possessions of men have been increased, or else larger populations have been supported to divide the increase. It is doubtful, however, whether increase of human happiness, beyond a relatively small modicum of possessions, is at all commensurate either with the growth of material wealth or with the growth of population. It seems that while science can largely increase general comfort and prosperity, it can, at present, ensure but little increase of happiness and contentment. Whether this must always and inevitably be so, is debatable, and depends to some extent on our definitions of science. In any case we must turn for help to moral and spiritual sources of happiness if we are to continue to become increasingly indebted for material wealth to the scientific revelations of the interpretable universe. At present it appears that advancement in the power to enjoy and give contentment is more difficult for us collectively to acquire than advancement in the power to secure material benefit through science and engineering. In the discovery and maintenance of these uplifting philosophies the calm and contemplative Orient has surpassed the tense and restless Occident."

An Egyptian Appointment.—The Egyptian Ministry of Education has appointed Mr. A. F. Wickenden, A.R.I.B.A., Assoc. M. Inst. C.E., as Professor of Architectural Design at the Cairo Polytechnic. Mr. Wickenden, who, in addition to carrying on private practice as an architect, has for many years been on the lecturing staff of the Imperial College of Science and Technology, has occupied important official positions with several leading municipal authorities in this country and has been associated as consulting technical editor with a famous publishing company.

The Old Liverpool University Students in London.—The second annual dinner of the Liverpool University London Society was held at the Florence Restaurant on Saturday, January 23rd. Professor Reilly—Roscoe Professor of Architecture—presided. Representatives of the University of Birmingham Guild of Graduates (London Branch) were present and expressed a desire to hold social events in co-operation with the L.U.L.S. The secretary, Mr. Harold Lloyd, 16, Blackheath-park, S.E. 3, would be glad to hear from old Liverpool University students with a view to enlisting their co-operation.

A Self-Slewing Derrick.

THERE was recently completed at the shipyard of Henry Robb, Ltd., of Leith, a full-sized experimental self-slewing derrick of patented construction, details of which are shown in the accompanying engravings, Figs. 1 and 2. The essential principle of operation upon which the self-slewing action of the derrick depends, is the alternate displacement of the derrick heel, either to port or to

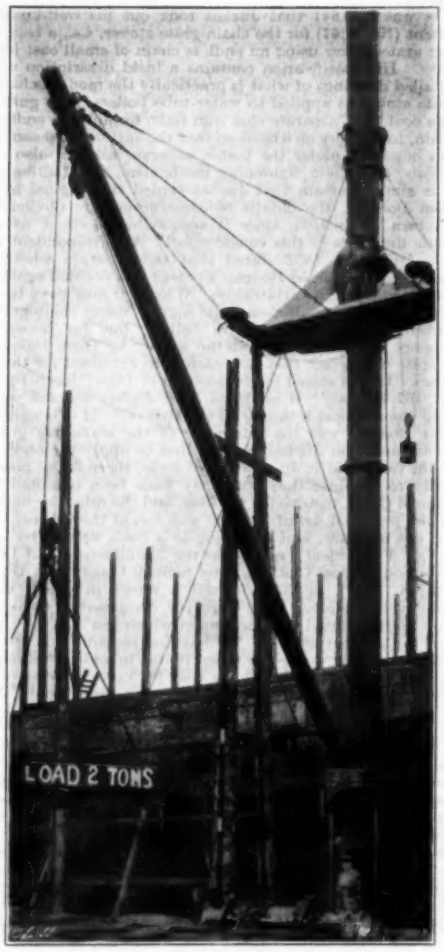


FIG. 1—SELF-SLEWING DERRICK

starboard, thereby producing what is equivalent to a list, which tends to swing the derrick in the desired direction under the action of gravity. Such displacement is effected by the mechanism of the ordinary cargo winch, the engine shaft of which drives through a clutch and gearing the main worm wheel fixed on the table carrying the derrick heel—see Fig. 2. The desired motion may equally well be obtained by a separate driving motor. The reciprocating movement of the heel carriage is effected by the familiar

FIG. 2—RECIPROCATING GEAR FOR DERRICK HEEL

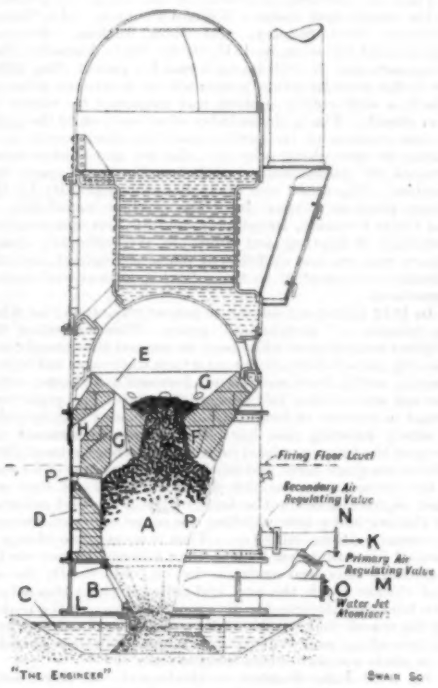
worm and wheel marine engine reversing gear, shown in Fig. 2, which provides an all-round motion.

The actual swinging of the derrick is controlled by a simple brake gear preferably fitted on the tee head of the derrick, as illustrated in Fig. 1. Under normal conditions the brake is always in operation, and it is only released when the slewing motion is actually required. The position of the derrick heel at any time is indicated by a pointer, reflected in a mirror placed adjacent to the driving position of the winch. The sequence of operations to be carried out by the winch driver are as follows :—Assuming that the load is to be lowered into the hold, the clutch is put into action, and the derrick heel is displaced in the requisite direction for the desired swing. The load is then lifted and when clear of the hatch coaming and of the top rails, the brake is released and the load swung over the desired position on the quay, where the derrick is brought to rest by the automatic brake gear. After the load has been lowered to the ground and while the hook is again being raised, clutching again takes place, and the heel is brought into position for the next swing. The brake is then released and the derrick automatically swings to centre, is arrested, and the load or hook lowered again into the ship's hold.

The new gear is claimed to be of special use for small coasting vessels, as it entirely obviates the hauling on the guy ropes, common in practice. For the larger cargo steamers in which two derricks are usually fitted, a self-slewing derrick and one winch will, we are informed, perform all the work required. The apparatus described is said to be particularly effective where bulk cargoes have to be handled by grabs. In such cases a patented hatch with gable-shaped ends is recommended, for it gives the winch man a clearer view of the work to be done. The self-slewing derrick gear and the hatch referred to are the subjects of patents by Mr. Gerald Gray, of 27, Martin-lane, Cannon-street, London, for whom the experimental set illustrated in this article was built.

A Producer-gas Fired Boiler.

WE recently had an opportunity of inspecting a steam boiler with a self-contained gas producer furnace which has been constructed and erected for experimental purposes in a works in Trafford Park by Wollaston Gas Producers (Manchester), Ltd., Bank of England Chambers, Manchester. The boiler, as far as the evaporative part is concerned, is of the vertical Cochran type, 6ft. diameter,



PRODUCER-GAS FIRED BOILER

but it is provided with a furnace of novel design and construction. The furnace is a simple gas producer A with a basket grate B and with a water bosh C for the removal of ashes. The refractory lining is formed with spiral air channels D round the periphery for preheating the secondary air. The crown is in the form of an inverted cone E with a central orifice F through which the fuel is fired by way of the normal fire door, and the working level of the fuel is maintained well up in the cone in order to keep the central orifice F sealed. The furnace crown is perforated with a number of burner orifices G for the escape of the gas made in the producer. These orifices are connected with secondary air ducts H, giving, when in operation, a Bunsen burner effect. Forced draught is produced by means of a fan K driven by any available means, the air supply duct being divided so as to deliver air to the grate annulus L and to the ducts H by way of the heating passages D. The relative quantities of air to support primary and secondary combustion are correctly proportioned by means of valves or dampers M N on the branches, while a water spray O in a finely atomised condition is supplied to the primary air to attain the most effective blast saturation for the production of gas, to prevent abnormal gas-zone temperatures and to avoid the formation of clinker. P P are poking holes.

It will be noted that practically the whole of the furnace and producer is composed of fire-brick, but that the greatest heat does not come into contact with this refractory material, the flames of air and gas issuing through the holes G, impinging against and spreading over the underside of the dome-shaped combustion chamber, the upper surface of which is covered with water. When we saw the boiler at work with coke breeze there was entire freedom from smoke and dust, while the amount of ash produced was singularly small and free from unburnt fuel.

The following figures are taken from tests which have recently been conducted on this boiler on behalf of Mr. W. M. Carr, engineer and manager to the Stretford Gas Board, and speak for themselves :—

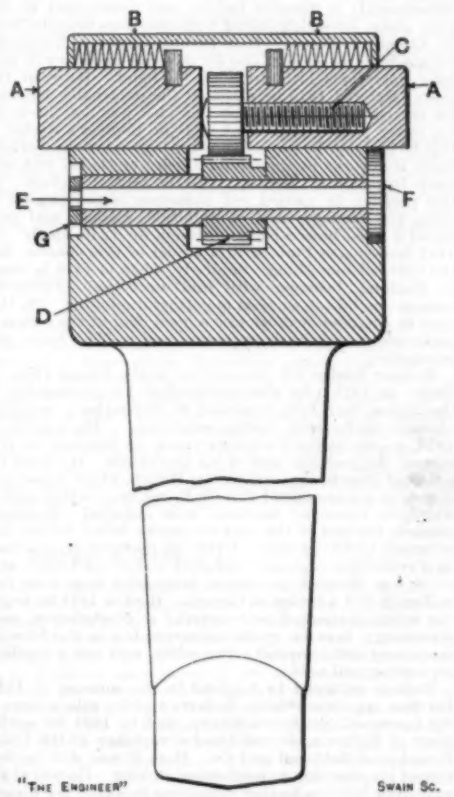
	No. 1 test, fire tubes open.	No. 2 test, retarders in fire tubes.
Fuel—	Coke breeze.	Coke breeze.
Moisture, per cent.	22·9	19·5
Ash, per cent.	17·5	25·3
B.Th.U. per lb.	8668	8028
Feed water—		
Temperature, deg. Fah.	49·5	46
Evaporation per lb. fuel as fed, lb.	4·91	5·05
CO_2 at chimney average (Orsat), per cent.	18·8	18·3
Gas temperature at chimney, deg. Fah.	737	633
Producer efficiency, per cent.	87·8	88·0
All-round efficiency, per cent.	66·3	73·8
Analysis of producer gas—	Per cent.	Per cent.
H_2S	1·4	1·1
CO_2	7·1	6·7
CO	20·8	22·2
H_2	14·3	13·9
N_2	56·4	56·1
	100·0	100·0

It will be observed that the gas temperature at the chimney is very high—too high. This might be reduced by passing the waste heat through a feed-water heater and a corresponding improvement in the all-round efficiency would be effected. An advantage of this type of boiler is that the fire will keep alight for long periods with little or no attention and with a very small consumption of fuel. By switching on the fan steam can be raised in a very short time.

A New Floating Reamer.

THE drawing which we reproduce below illustrates a new form of adjustable reamer, recently brought out by David Brown and Co., of Huddersfield, which, it is claimed, embodies the three essential characteristics of an efficient tool of this class, viz., two cutters, short cutting edges and complete lateral freedom of the cutters in the shank. Reamers embodying some of these features have, of course, been produced before, but the tool under review is noteworthy on account of the simplicity of its construction.

On reference to the drawing it will be seen that the two cutters A A are housed in a transverse slot in the head of the tool, and are pressed together by two springs B B. One of the cutters is drilled and tapped for the screw C,



ADJUSTABLE REAMER

which has a rounded end to bear against the opposite cutter. Between the two cutters the screw is provided with a head in the form of a toothed wheel, which meshes with another, correspondingly toothed, wheel D on a parallel spindle. It will be readily understood that the setting of the cutters, for the diameter of the hole to be reamered out, can be effected by turning the spindle, and consequently the screw, while, at the same time, the two cutters will always be free to move transversely through the slot to accommodate any lack of alignment.

In order to facilitate the setting of the tool to any actual diameter the spindle on which the wheel D is mounted is made in two parts. That is to say, it is really a sleeve with a separate internal bolt E. The head F of the bolt is graduated to represent thousandths of an inch diametrical movement of the cutters, and a nut G is provided for clamping the bolt and sleeve together. On this account the cutters can be quickly set to a nominal size, by gauge, and the bolt head F set to a zero mark. Then the nut G

is tightened up and the final adjustment, to thousandths or less, made by turning the bolt and sleeve together by means of a pin spanner. A grub screw in the side of the tool is used to lock the adjusting gear and prevent the setting being changed.

The makers inform us that when using a 1¼in. reamer, feeds as great as ¼in. per revolution can be employed for medium carbon steel and yet leave a perfect finish. The reamers are made in a number of standard sizes for diameters from 1in. up to 24in. The smaller sizes have a range of adjustment of about ¼in., while the largest will ream any hole between 20in. and 24in. in diameter.

John George Bodmer and Mechanical Stoking.*

By DAVID BROWNLIE, B.Sc., F.C.S., M.I. Chem. E.

JOHN GEORGE BODMER, born at Zurich in 1786, was possessed of an extraordinary genius for mechanical invention, combined with a profound practical experience obtained in a long life spent in many different countries. In his day he was one of the leading authorities in a great range of subjects, including munitions of war, machine tools, steam engines, cotton spinning and textile machinery generally, rubber machinery, and railways and railway material, including both locomotives and rolling stock. To deal adequately with every section of Bodmer's activities is impossible here, and it is proposed to give first a concise description of his life and work in general, and then to consider in some detail his contribution to the development of mechanical stoking, a subject that is very inadequately discussed in the Memoir in the "Proceedings" of the Institution of Civil Engineers (1869, Vol. 28), which is our chief source of information about Bodmer. It is hoped to show that the chain-grate stoker originated with him and not with John Juckes, as is usually supposed, and in this connection to consider the bearing of the labours of Samuel Clegg in the early days of the gas industry.

BODMER'S LIFE AND WORK.

Even as a child Bodmer showed signs of great inventive ability; when thirteen to fourteen years old he was apprenticed to a millwright, and at the end of his time he started a small workshop for general repair and millwright work. In 1806, at the age of twenty, he constructed a percussion shell for muzzle-loading rifled cannon. In the same year he, with a partner, commenced the construction of a cotton mill in the Black Forest; for this he designed and erected not only the water wheels and general equipment, but much of the spinning machinery as well. Subsequently a firearms factory was established at the same place, for which skilled workmen were brought from St. Etienne in France. Here Bodmer displayed his genius for machine tool design and for devising machines to perform operations hitherto done by hand. Between the years 1809 and 1813 he invented the detachable bayonet for breech-loading rifles, but this idea was not taken up for many years. The next step in Bodmer's career is that he took up the post of Director-General of the Government Ironworks in the Grand Duchy of Baden and was made Inspector of Artillery, with the rank of captain. In this position he carried out numerous improvements in guns, gun-carriages and ammunition wagons, and produced a rifled breech-loading cannon for 12 lb. shells. In 1812 he went to Paris with a model of this cannon, but the visit led to nothing. Similarly, when in 1816 he came to England, bringing with him an actual 12-pounder cannon, he did not succeed in getting it adopted. On this visit to England Bodmer saw a good deal of the country, particularly its workshops, cotton and woollen mills, and ironworks.

Bodmer finally left the service of the Grand Duke of Baden in 1821; he also relinquished his partnership in the cotton mill, and, returning to Switzerland, occupied himself chiefly with textile machinery. Then early in 1828, at the age of forty-two years, he returned to this country to push the sale of his inventions. He lived for a time at Manchester, and then at Bolton, where in partnership with a man named Novelli he set up a cotton mill in which his improved machines were installed. However, towards the end of the year his health failed and he had to return to Switzerland. Upon his recovery he practised as a consulting engineer, installed cotton machinery at a factory at Munster, in Alsace, designed a large flour mill in Zurich and a bridge at Geneva; then in 1831 he began the reorganisation of an ironworks at Niederbroun, near Strasburg; here he made improvements in the blowing machinery and invented a bar rolling mill and a machine for cutting nail rods.

Bodmer returned to England in the summer of 1833. He then appointed Sharp, Roberts and Co. sole makers of his improved cotton machinery, and in 1834 he settled down in Bolton again and hired a workshop at the Union Foundry of Rothwell and Co. Here it was that he first turned his attention to mechanical stoking. He was at the same time busy on further inventions in cotton machinery, and with his double-piston balanced steam engine with two pistons moving simultaneously in opposite directions (Patent No. 6616/1834). The first engine, a 10in. cylinder, was set up in the Union Foundry; each piston actuated a separate crank on the same shaft, so that the power applied was balanced. Bodmer was the first to realise and understand the stresses and strains set up by the unbalanced parts of an engine in motion. This design was intended primarily for locomotives and Bodmer's patent specification of 1834 shows a machine of advanced design, including variable-speed gear, metallic packing, and a special design of piston ring. The specification of a later patent (No. 10,243/1844) shows a still further improved design, embodying another type of link motion, corrugated fireboxes, and rocking furnace grates. There is strong evidence that the Meyer expansion valve and the Rider valve were both originally invented by Bodmer. His first locomotive seems to have been built in 1842 and in 1844–5 he supplied three engines to the London and Brighton and the South-Eastern Railways.

* Abstract of paper read before the Newcomen Society, January 27th.

Bodmer was consulted by Mr. Provost, one of the original directors of the London and Birmingham Railway, in regard to the laying of the track and the design of carriages. It was in this connection that he evolved the design of a corridor coach. In 1845 he gave evidence before the Railway Gauge Commission. Altogether his work in this field is of a remarkable character. Thus, apart from the balanced engine itself, he designed what is essentially the modern four-cylinder balanced locomotive. Connected with railway work is his mill for rolling tires for wheels which was set up in 1844 at P. R. Jackson and Co.'s Salford rolling mills.

Bodmer's inventions in machine tools include the circular planing machine, and, it is believed, the band saw; he applied the principle of the pantograph for shaping and cutting metals, and was the first in Great Britain to use the metric measurements in an engineering shop. He built many stationary engines; one of them, a vertical, put up in 1846, was working up to two months ago at the works of Messrs. Bridson and Sons, in Bolton.

Between 1837 and 1846 Bodmer did some remarkable pioneer work in the design and construction of rubber machinery for Charles Mackintosh and Co., of Manchester.

In 1846 he removed to London, and in 1848 he returned to the Continent and settled down for a few years in Vienna, where he did much consulting work in connection with beet sugar machinery. Leaving Vienna, he took up his residence at a village in the vicinity, where a friend of his owned a small engineering works. Here he busied himself with safety valves, water gauges, an anti-incrustation apparatus, a feed-water regulator, and a feed-water meter.

In 1860, when he was seventy-four years of age, Bodmer returned to Zurich, and here he died in 1864, after a life of achievement covering a field extraordinarily wide and important. As may be inferred, he was a man of very strong individuality and almost tireless energy. It is stated that in his younger days he often went without food or sleep for thirty-six hours at a time, and even when very old he regularly got up at five o'clock in the morning, so as to have as long a day as possible.

MECHANICAL STOKING.

There are four men who may be said to be the pioneers of the mechanical stoker—William Brunton, John George Bodmer, John Stanley, and John Juckes. Brunton commenced his work in 1817 at the Eagle Foundry, Birmingham, and in 1819 he took out his patent (No. 4387) for a flat circular grate supported on a central pillar to which a slow rotary motion was imparted by means of gear wheels. The coal was fed continuously on to the grate at one portion of its surface and travelled round as it burnt, on the coking principle, the ash and clinker being scraped off mechanically just before the coal hopper was reached. The speed was controlled automatically by the steam pressure. Apart from the original installation at the Eagle Foundry, Brunton erected his first stoker at the distillery of Liptrop and Smith in Whitechapel; many others were erected in different parts of England, and the principle was applied to the calcining of ores and similar operations.

In 1812 Brunton took out a patent (No. 4685) for what he termed a "peristaltic" grate. This embodies the original invention of what may be termed the straight line moving grate coking stoker, in which the coal is fed from a hopper at the front and travels forward as it burns, while the ash and clinker fall over at the end. The grate consisted of a series of longitudinal bars placed side by side; a slowly rotating cam bar placed across underneath the front of the furnace caused each alternate bar to rise slightly above the grate level and at the same time travel forward a few inches, carrying the charge. This set of bars was then depressed below the level of the grate and returned to the original position, when the other set went through the same motion, and so on. That is to say, the charge is carried forward a few inches, then allowed to rest on the stationary bars, and again carried on, until finally the ash and clinker reach the end and fall over into the ashpit. The bars were designed to give more air space at the middle of the travel than at the ends, and the coal was fed by a reciprocating ram. It is not known whether Brunton ever made a stoker of this construction.

In 1822 John Stanley, a blacksmith, of Manchester, patented a sprinkling stoker, whereby the coal was continuously sprinkled or flicked on to a grate with stationary bars. This stoker, modified according to a later patent of 1834, was applied all over England.

In 1834, therefore, when Bodmer returned to his workshop in Bolton and took out his first patent for mechanical stoking, there were already two main types of stoker quite well known and in fairly extensive operation, as applied to externally fired boilers, *i.e.*, Brunton's revolving grate and Stanley's sprinkling device; many other patents had been taken out, and in the engineering papers about 1830 the patent action Galloway and Cochrane *v.* Braithwaite and Ericsson had occupied considerable space.

Bodmer, in this patent of 1834 (No. 6617), stated clearly that his object was to burn coal on the coking principle by carrying it gradually, slowly and continuously through a furnace, with careful regulation of the air supply, until nothing but ash and clinker is discharged at the end of the travel. Three methods of carrying out the travel of the coal are described:—(*a*) An horizontal cylindrical cage is mounted under the boiler with its axis parallel to the front and is slowly rotated, the upper part of the cage constitutes the grate; the coal is fed on at the top from a hopper at the front of the boiler and is burnt as it is carried forward by the motion of the cage to a point at which the ash and clinker is scraped off. A stoker of this construction was set to work in Manchester in 1837, but it was not a success.

(*b*) The coal is caused to move straight forward on a travelling grate composed of a number of carriages or short sections provided with wheels to run on horizontal rails in the ashpit; the grate is pushed forward by a reciprocating ram to the extent of one section at a stroke; the foremost carriage moves off the rails on to a device which transfers it to a second set of rails inclining downwards to the front of the boiler; the carriage runs down the rails into a hoist whereby it is lifted into the plane of the grate again. A guillotine coal feed device is used, *i.e.*, a vertical shutter, which is raised or lowered to control the amount of coal being supplied from the hopper.

(*c*) A downwardly inclined grate is mounted on four upright rocking levers, and is given a vibratory motion which throws the coal forward. This seems to be the pioneer invention of the rocking grate stoker. It is not known whether Bodmer applied either his second or his third method in practice.

As a modification of the second method Bodmer proposed to connect the fire-bars in an endless chain. In his specification he says:—"I would here remark that a propelling or travelling grate may be constructed by a series of fire-bars attached to an endless chain passed over conducting rollers and actuated in any convenient manner." It is clear from this that Bodmer had originated the chain-grate stoker some years before John Juckes took up the matter.

It was in 1841 that Juckes took out his well-known patent (No. 9067) for the chain-grate stoker, *i.e.*, a travelling grate stoker using an endless chain of small cast iron links. His specification contains a lucid description and detailed drawings of what is practically the modern chain-grate stoker as applied to water-tube boilers, with guillotine coal feed, separate cast iron links forming an endless chain, framework on wheels so that the entire stoker can be run out from under the boiler, separate ashpan, also on wheels, and chain tightening mechanism. But although it is almost certain that Juckes copied the original idea from Bodmer, the details of construction are obviously his own production, since it seems that Bodmer never made drawings of this construction. A correspondent of the *Artizan* in 1852 stated that the question whether Juckes had infringed Bodmer's patent was decided against Juckes at a private arbitration. Whatever may have been the legal position, Juckes made a great many chain-grate stokers, not only for steam boilers, but for brewers' coppers as well. He made no money by them though, in spite of the fact that his patent was extended for three years. It was stated in *Engineering* in 1886 (March 16th, pp. 167–8) that, "If not dead, poor Juckes was not very long since almost a beggar in the streets." If it is agreed that Bodmer was the originator of the travelling grate stoker and that Juckes was the first to apply the endless chain variety of it on a practical scale, there is the possibility to consider that both may have been indebted to Samuel Clegg, the one for the idea, and the other for many of the practical details. Clegg was one of the pioneers of the gas industry, and according to a book written by his son ("A Practical Treatise on the Manufacture and Distribution of Coal Gas, &c.," by Samuel Clegg, jun., third edition, 1859), he had devised a retort in which was employed an endless band conveyor, composed of wrought iron plates jointed together, upon which the crushed coal was fed and carbonised. We have no record as to where this retort was worked or when it was invented; perhaps the date may be placed at the year 1825 or a little earlier. Many of the details of construction, as described in the book, are the same as Juckes' design of chain-grate stoker of 1841.

To return to Bodmer. In 1843, at the age of fifty-seven, he again took up the subject and patented another form of travelling grate stoker in which a series of transverse fire-bars engaged at their ends in a pair of longitudinal screws, the rotation of which carried the bars forward. At the end of the movement the bars drop out of these screws and engage another pair of screws of large pitch, which return them to the front of the boiler. The upper screws have drunken threads so that as the bars travel forward they are given a slight to-and-fro or tilting motion, which makes the grate self-cleaning and aids combustion by "lifting" the coal. In addition, the screws are cut with an increasing pitch so that as the bars travel along the air spaces become wider. In this way the rocking motion of the bars does not cause the unburnt small coal to fall through, but as soon as combustion has fairly commenced and the heated material has attained some degree of viscosity and the clinker increases, then the air spaces widen out. This form of stoker was applied to three boilers at the bleach works of Messrs. Bridson, of Bolton. One of the first troubles was to keep the coal burning at the commencement of the travel. To meet this, Bodmer introduced a fire-brick arch, on exactly the same lines as the sprung arch in use to-day. This was not an original invention; it had been proposed by Thompson in 1796. After this alteration the three stokers worked very well, giving a regular fire with no smoke and burning very small slack without difficulty. However, the familiar trouble of mechanical stoking then developed—wear and tear and cost of upkeep. The screws, although protected as much as possible, got very hot and could not be lubricated properly and then the threads began to grind and wear rapidly; it followed that the bars did not remain in the correct position in the screws, but were displaced and jammed, so that the stoker stopped or a serious breakage took place.

A number of these stokers were erected in different parts of the country; one at Old Ford, near Bow, in London, had a grate 9ft. 6in. by 2ft. 6in.; another for the Croydon Railway was 15ft. by 2ft. 3in. A model made by Bodmer is to be seen at the Science Museum, South Kensington, and the apparatus is described in a paper read by him before the Institution of Civil Engineers in 1846. In this paper he shows a hollow water-cooled cast iron bridge at the end of the grate, explains clearly the principle of the coking stoker, and states that it is best to work with a forced draught fan at 2·3in. water gauge.

The application of the chain-grate stoker declined with the advance of the internally fired Lancashire boiler. Obviously such a stoker is not suitable for these boilers, but attempts were made to get round the difficulties. In the Whitworth and Wrigley plan the stoker operated in a fire-brick chamber placed in front of the boiler; this was expensive and took up much valuable space.

With the introduction of the water-tube boiler, however, the chain-grate stoker again sprang into prominence, and not so very long ago a very large proportion of all the water-tube boilers of the world were fitted with such stokers.

THE late Sir R. A. Allison was a director of the Midland Railway until it became part of the London, Midland and Scottish Railway. His name should be remembered, as he was a man who took an active interest in the welfare of railway servants.

Provincial Letters.

THE MIDLANDS AND STAFFORDSHIRE.

(From our own Correspondent.)

Faith in Future of the Engineering Trades.

CONSIDERABLE remark has been aroused in the Birmingham district by the statement on foreign competition in the engineering trades mentioned in my letter last week, made by the chairman of John Thompson (Wolverhampton), Ltd. Unanimous approval is given to the remarks made by Mr. James Thompson respecting what he believes to be the sound position occupied by numbers of our home trades. The striking faith in the future of British industry which he professed is received with great respect. Remark has been made upon the iron exchange this week that the championing of the up-to-date capabilities of the country's industries by Mr. Thompson should do the Birmingham district in particular real service. No less important are his views upon what the engineering trades need for the future. On the occasion to which I referred last week he laid stress on the future advantage to our manufacturers in respect of raw material supplies wrapped up in the extension of cultivation in the Soudan. Ultimately, 3,000,000 acres would be put under cultivation there, thanks to the recently completed Sennar Dam irrigation scheme. It was all to the good, too, that 10 millions sterling were to be spent in opening up East African transport. Mr. James Thompson said that his confidence in the future of trade prosperity was based on the belief that our industrial magnates, whether in the cotton, steel or engineering trades, would at an early date really see to it that their works were efficiently equipped with modern plant. Admittedly, the prolonged drain of Imperial taxation made the matter most difficult, but like many others he was convinced that firms which were not prepared to face this difficulty would soon find themselves out of business. Works organisation must also be overhauled. Finally, Mr. James Thompson entered a plea for giving the workers a pecuniary interest in profits. Just as, in recent years, the population of the country had taken increasing interest, and demanded a bigger voice in government, so the workers were now requiring to be consulted in the conduct of industry. That being already the situation, he felt sure that far-seeing employers would be well-advised to meet the men. Some firms which had given the proposition a fair trial were satisfied that if sympathetically handled, the change could be made the means of untold saving. A material increase in output had also in stated cases resulted. New wage adjustments would, of course, be needed from time to time, but in his judgment under some sort of profits-sharing scheme lower working costs could be effected without recourse to drastic wages reductions.

Colonial Development in the Engineering Industry.

Inquiries which I have caused to be made from Mr. James Thompson, chairman of John Thompson (Wolverhampton), Ltd., concerning the lessons to be learnt from his recent prolonged business visits to Australia and South and East Africa, elicit that he has returned filled with admiration of the efforts which those countries are making to establish home industries. Even so, however, he is in no uncertain mind respecting the large prospects which the engineering trades in this country in particular still have of doing business with the Dominions. From his own knowledge of the present conditions of native industry in the Dominions named, he declares that he has a great hope for British engineering houses in the years that are in front of us. Although the fact has to be faced that the development of Dominion industries within their own borders will certainly continue, very many years, Mr. Thompson argues, must elapse before they will become able to supply anything like all their own needs. At the present time he believes the Dominions and Colonies are always prepared to give British engineering productions the preference over foreign, if only there is not too great a difference in the matter of price. The establishment by British firms of branches of their home works in the Dominions or of entirely separate concerns, must be a matter calling for very careful consideration, even though they may have native tariffs to assist them. Respecting British productive capacities at date at home, Mr. Thompson affirms that entire home industries and firms could be categorically named which are not only successfully holding their own, but are developing enormously.

Fighting Foreign Competition.

Considerable interest was aroused the country over by the recent announcement of the Birmingham Chamber of Commerce that many firms are determined to meet their rivals from abroad on equal terms. Direct evidence of the new fighting spirit and of the intensive efforts of manufacturers to displace many kinds of foreign-made goods, which have secured a hold on home markets, is provided by particulars of some of the more notable exhibits at the Birmingham section of the British Industries Fair, to be held this month, which are specially designed to supplant similar articles of foreign manufacture or otherwise as a direct challenge to foreign competition.

Railway Requirements.

A variety of Birmingham trades, as well as those of South Staffordshire, have benefited by the entry of the railways into the market for all sorts of supplies, including fitments and essentials on a large scale for rolling stock. One of the trades of the district, namely, the coach axle industry, makes a side-line of railway buffers, side bars and similar essentials to wagon building, and a remarkable number of inquiries from railway builders is in the market, and they promise to keep these firms busy for some time.

Locomotive Orders.

Some important contracts have just been placed with Midland engineering firms, amongst them being that for twenty-five superheater locomotives for the London, Midland and Scottish Railway Company, placed with Kerr, Stuart and Co., Stoke-on-Trent, and that for fifteen locomotives of the tank type for the same company, placed with W. G. Bagnall, Stafford.

Halesowen Tube Trade.

There has been a considerable improvement in the tube trade in the Halesowen and Oldbury districts during the past week, and there are signs that at least for the next nine or ten months something in the nature of rush conditions will be enjoyed by a large section of the industry. Many of the firms are busier than at any period since the war. Several extensive orders have been booked, both for at home and abroad; and one or two firms have sufficient contracts to keep their works at full swing until the end of the year.

Proposed Beet Sugar Factory.

I understand that a committee of the Herefordshire branch of the National Farmers' Union is considering a proposal for the erection of a beet sugar factory in Herefordshire. It is well known that the acreage of beet that will be grown during the coming year, compared with last year's crop, shows a considerable increase, and it is urged in many quarters that with the facilities Herefordshire offers, it would be almost impossible to select a better county for a factory throughout the South-West Midlands.

Ironworkers' Wages Reduced.

Midland ironworkers' wages, regulated under the sliding scale of the Midland Iron and Steel Wages Board, are to suffer another reduction. As from Monday next they will be reduced by 2½ per cent., bringing puddlers' remuneration down to 55 per cent. above the basis rate of 13s. 6d. This is the fourth successive depreciation.

Unprofitable Steel Prices.

Producers of steel in the Midlands complain that prices have been brought down to an unprofitable level, but competition is as keen as ever for the business which is being offered in this district, and efforts to get higher prices have little chance of success. The improvement in demand is continued, though it is unevenly distributed. Fairly heavy tonnages of constructional material are being called for, and railways are good buyers of steel requisites over a wide range. A slight improvement in orders for ship plates has also developed, but heavier tonnages are needed to give employment to the largest and most powerful plant. The foreign situation has changed rather favourably to this country, with prices showing an upward tendency. The weakest department in steel is the re-rolling section in which the Staffordshire mills are keen competitors, wrought iron orders coming in insufficiently to keep the mills engaged. Bars and steel strip are rather easier at £7 15s. The only change of note in steel is the lowering of prices for wire rods, which will enable rollers the better to meet the continental competition to which this branch has so long been subjected. While English billets remain at about £6 2s. 6d., Belgian products have advanced substantially, the latest quotation being £4 11s. 6d. f.o.b. Antwerp, or about £5 11s. 6d. delivered here. This is an advance of about 6s. per ton over the price which ruled at the opening of the quarter. The margin between English and Belgian prices has therefore become narrower, and British users generally consider a margin of much more than 11s. per ton is necessary to counterbalance the slow deliveries, cash payments and quality risks associated with the buying of foreign steel. In consequence, various inquiries for foreign billets have not resulted in business, and Midland steel works are supplying consumers' needs. An increased amount of this business is looked and hoped for.

Staffordshire Bar Iron.

Business in the Staffordshire bar iron industry shows no marked improvement on the week. In view of the higher cost of pig iron, sellers of iron are inclined to show a stiffer front, though not to the extent of prices being quotably dearer. They have no desire for values to be forced up, in case increased prices should check the little improvement that has recently been noticeable. Marked bars are firm at £14. Crown qualities are not now offered by so many mills at the Lancashire price of £11 10s., many Staffordshire makers asking the Association basis price of £12. The resumption of the ironworks in the Charleroi district of Belgium enables exporters again to promise deliveries of Belgian No. 3 iron for nut and bolt making within four to six weeks. The current quotation is about £7 to £7 2s. 6d. delivered here, and at £10 10s. the Staffordshire price cannot be considered competitive. Wrought iron gas tube strip is in better request at round about £12 10s.

Galvanised Sheets.

In the galvanised sheet department new business is not coming forward as quickly as old contracts are running out. The market level is about £16 7s. 6d. f.o.b. for export and at works for the home trade. This figure applies to 24 gauge sheets, but recently a fair amount of business has been placed for 26 and 28 gauges, for which the customary extras are charged.

Pig Iron and Fuel Costs.

The position in the pig iron industry is substantially unchanged. The demand from the foundries is moderately good, judged by the recent rate of output. Developments in the engineering foundries appear to be more dependent on stability in market conditions. At the forges the situation remains precarious. Derbyshire iron is selling rather more freely in the Manchester market. The demand, it is thought, would absorb the output of additional furnaces, but owners will not undertake the large expense of re-lighting, with the possibility of having to damp down or blow out a few months hence. Similiarly, the maker of pig iron will not contract at the present low price until he knows more certainly what he will have to pay for his coke, or, indeed, whether fuel will be available. Leading managers of works in South Staffordshire would be glad to buy pig iron over several months if their orders could be accepted. The uneasy feeling which exists, owing to the uncertainty of the fuel position, deters smelters from entering into distant contracts. The end of March is about the limit to which they will go. By that time, presumably, coke prices will again be reviewed. Derbyshire No. 3 foundry iron is stationary at about £3 7s. 6d. at furnaces; a higher quotation is heard of, but sellers admit that it cannot be got. Northamptonshire foundry commands from £3 4s. to £3 5s. Very little support is extended to the forge side of the industry. Values are low and difficult to determine.

Death of Stafford Works' Founder.

Founder of the firm of Dorman and Co., Ltd., engineers, of Stafford, Mr. W. H. Dorman died at Stafford on Friday last, at the advanced age of ninety-three. In 1875 he commenced, in partnership with Mr. W. Walker, the engineering business which has been carried on in Foregate-street ever since. At first the firm was known as Dorman and Walker, but subsequently it was converted into a limited liability company, W. H. Dorman and Co., Ltd. Mr. Dorman retired from the business in 1911.

Unemployment.

During the last few weeks the figures showing the number unemployed in the Midlands have, in turn, increased and decreased. The current return indicates a substantial improvement, the total number of workers wholly unemployed being 134,448, as compared with 139,891 the previous week, being a decrease of 5443. At the same time, the number of partially unemployed persons has decreased by 2515.

SHEFFIELD.

(From our own Correspondent.)

Heavy Steel Trades.

IT is reported that iron and steel makers on the coast are getting busier with oversea orders, and if this upward movement develops, Sheffield should begin to feel its effect. The competition from the coast furnaces, however, is too formidable at present, these places naturally having a big pull over the inland areas, which are handicapped by rail charges to the ports. Complaints as to the slow manner in which work is coming through for the furnaces in Sheffield and district are heard frequently, and there are many business men in the city who frankly admit that they are disappointed at the trade returns for the opening month of the year. A few firms seem to be fairly busy, but others are having the greatest difficulty in disposing of their output of material, greatly below capacity though this is. Steel makers have a further cause for complaint in the prices they state they are having to pay for raw materials. They are having to find more money for their purchases, but are unable to get anything extra for their products. The last few movements in steel prices have been downward, and though some buyers are proceeding very cautiously for fear that the market should move against them, it is difficult to see how Sheffield makers could afford to give any more concessions. Little trade is passing in the scrap market, users of heavy basic steel scrap for melting declining the merchants' terms of 62s. 6d. per ton delivered.

Stainless Steel Production.

One of the most hopeful sections of the Sheffield steel trade is that concerned with the production of stainless or rustless material. Last year there was a record output of these steels, thanks to commercial enterprise steadily extending the scope of their application. Developments in this connection have virtually just begun, and the research workers have by no means solved all the problems with which they are faced in this comparatively new branch of metallurgical science. Experiments are continually proceeding, and with these steels being adopted more and more for popular uses, particularly in house furnishings, the output this year should easily beat even last year's record.

Engineering Orders.

Sheffield does not figure as sharing directly in the order for 200 locomotives, which is to be placed with outside firms by the London, Midland and Scottish Railway. Hadfields, Ltd., of Sheffield, however, have a large holding in the Vulcan Foundry, Newton-le-Willows, which is to build 50 locomotives of the six-wheeled tank type. Twenty-five locomotives of a similar class are to be built by the Hunslet Engine Company, of Leeds, and will keep it busy for six or eight months. I referred last week to other useful railway orders which have come to Leeds of late. One of these is for 30 all-steel Pullman cars for the Continent, and I now notice that Sir Davison Dalziel, Bart., the chairman of the Compagnie Internationale des Wagon-lits, pays a very high tribute to the work of the Leeds Forge. It was this company that built the famous Blue train which runs from Paris to the Riviera, and it was owing to this splendid piece of work, and because the Sleeping Car Company was so completely satisfied with the craftsmanship displayed, that it decided to place this further order with the Leeds Forge Company. The order was secured in face of severe foreign competition, and, to quote the words of Sir Davison, "I hope there will be more orders to follow." The trials of a new type of tank manufactured at the works of Vickers Ltd., attracted large crowds in the Brightside and Wincobank districts of Sheffield. This new instrument of war carries several guns, and is said to be capable of travelling at a high speed. The general manager of the Sheffield Electric Supply Department has reported that with the contemplated interchange of supply of 10,000 kilowatts between Sheffield and Rotherham Corporations, and the replacement of an 8500-kilowatt turbo-alternator at Neepsend by a new plant of 10,000 kilowatts, extensions of the generating station at Blackburn Meadows can be postponed. The acceptance is recommended of the quotation

of C. A. Parsons and Co., of £32,050 for a 10,000-kilowatt turbo-alternator.

Plate and Cutlery.

Trade is extremely quiet in plate and cutlery. This is usual at this time of the year, on account of the absence of an inland demand, and matters unfortunately are made worse on this occasion because of a drop in overseas bookings. The orders arriving are for smaller lots and of cheaper quality than was the case at this time last year, and the bulk of this work appears to be going to the small makers. The large firms have very little work in hand, and have not yet re-started all the men who went on holiday after Christmas. In scissors, pen and pocket-knives and other classes of cutlery, which are open to foreign competition, there is hardly any trade passing, which is not surprising in view of the heavy dumping that occurred at the end of the year. In many big-buying centres, too, certain people seem to be making special efforts in pushing the sale of German novelties. One of the best sections is that comprising table knives. The Sheffield stainless variety is popular, and foreign competition hardly touches it. The tool trades are busy, a notable order recently secured being that of Sheffield Steel Products, Ltd., for 12,000 pairs of electricians' pliers for the Post Office.

Railway Construction.

The jointly promoted Bill of the London, Midland and Scottish and the London and North-Eastern Railway Companies for the construction of new railways into the Nottinghamshire coalfields has been deposited. It will be recalled that last year the companies promoted Bills for competing railways, and there were strong protests by those who thought that the proposals would destroy the beauties of the Dukeries. The new joint scheme provides for the construction of about 28 miles of new railways. The line will commence at Hucknall with two junction railways, one connecting with the Nottingham and Mansfield Railway of the London, Midland and Scottish Company, and the other with the Leen Valley line of the London and North-Eastern Company. From Hucknall the line will proceed for a distance of over 23 miles to Babworth, where it will connect by two junctions with the Sheffield and Grimsby line. The branch lines include one to the Ollerton Colliery.

Colliery Engineering Feat.

A further step in the developments at Denaby Main Colliery has been completed by the full working for the first time of the recently constructed No. 2 shaft for service to and from the Parkgate seam. The managing director of the Denaby and Cadeby Colliery Company, Major J. H. Leslie, speaking at a meeting recently, said that the No. 2 shaft had been made in the nick of time, and that a great engineering feat had been accomplished. There was nothing quite like it in England. He also remarked that it was no exaggeration to say that the company would have had to close the Barnsley seam if it had not sunk the other shaft. The shaft is 706 yards deep. On the first day 1300 tons of coal were raised, and it is hoped to bring the figure up to 2000 tons a day in a short time. The arrangements for loading coal and controlling the air in the new shaft are among the most up-to-date in the country. Other improvements at this colliery include a new fan, new compressors and a new boiler.

New Constructional Method.

Mr. D. Davidson, lecturing before the Yorkshire branch of the Institution of Structural Engineers, described his invention of a new system of reinforced concrete construction, with particular reference to its adoption by Mr. G. A. Hart, the Leeds sewerage engineer, for the extensive foundations of the new sewage tanks at the low-level sewage disposal works. When completed this system, it is claimed, will have effected a saving of over £115,000 on work that otherwise would have cost £215,000. Mr. Davidson explained that his invention was the simple application of the first principles of structural engineering, namely, that the transmission effect of a load on a floor should be carried directly to each support of a floor by the shortest route and without beams to interrupt direct transmission. He showed that by his method for the distribution of steel reinforcement in concrete floors every steel wire was doing its full duty. In the case of the Leeds works the floor had to be carried by a semi-liquid river silt of an average depth of 10ft. over a bed of gravel. The floor supports consisted of reinforced concrete cylinders, 6in. thick and 9ft. external diameter, filled with concrete after being sunk through the silt. Between their centres the cylinders were spaced 24ft. apart on the average.

LANCASHIRE.

(From our own Correspondents.)

MANCHESTER.

The Engineering Trades.

ALTHOUGH there is no material all-round improvement in the state of the engineering industry of this district, it is pleasant to be able to report that several of our heavy machine tool building firms are somewhat better employed than they have been for some time. I am afraid, however, that the business has, in many cases, been taken at prices which are scarcely remunerative. Still the signs are more hopeful than they were six months ago. I understand that some of the orders have come from Russia. Locomotive builders are also fairly well placed for work, and one firm of engineers in the district has a fair number of oil engines on order.

Cost of Generating, Transmitting and Distributing Electrical Energy.

"The Cost of Generating, Transmitting and Distributing Electrical Energy" was the title of a paper read on Wednesday, 27th ult., before the Manchester and District Association of the Institution of Civil Engineers, by Mr. S. J. Watson, M. Inst. C.E., M.I.E.E., electrical engineer to the Salford Corporation. The author's objects were to indicate the different processes through which the supply as originally generated at the power station may have to pass before it is available for use, and to show by figures how each process, together with the operation of certain other factors, influences the ultimate cost to consumers. Mr. Watson divided the total costs of supply into six parts, viz.:—Power station; main transmission; secondary transmission; transformation and conversion; distribution, including service; metering, account rendering and collecting. As an example he took a power station having an installed plant capacity of 100,000 kilowatts and a transmission, converting and distribution system suitable to dispose of that output. He said that the initial expenditure would be approximately as follows:—Land and clearing, £50,000; sidings or wharves, £75,000; buildings, £350,000; turbo alternators, £425,000; boilers, £400,000; water circulation, £75,000; switchboard, £100,000; and sundries, £25,000; total, £1,500,000. Assuming a thermal efficiency of 20 per cent., a maximum load of 70,000 kilowatts and 40 per cent. load factor the works costs would be ·171d. per unit, and the total costs, including rates, taxes, capital depreciation, and reserve, ·341 per unit.

Research in Ironfounding.

An interesting paper, dealing with the "Value of Research in the Production of Castings," was read before the Manchester Association of Engineers on Friday, 29th ult., by Mr. J. G. Pearce, B.Sc. (Eng.). The first group of illustrations showed how every-day difficulties may be explained and corrected by metallurgical knowledge and experience based on research. The second group showed how current research work is resulting in developments which call for serious attention. The author said that in making economical castings some German works now utilised large percentages of scrap, up to 90 per cent., which had necessitated a desulphurisation process and a suitable desulphuriser had been devised in the form of a briquette of alkalies and alkaline earths. The latter were normally good desulphurisers, and it was found by investigation that their high melting points could be reduced by admixture with the former in certain suitable proportions. This process, it was stated, had necessitated arrangements whereby all the slag must be separated from the iron before desulphurising, as the desulphuriser attacked silicic acid in the slag and might result in all the sulphur being returned to the iron. Although there was not necessarily much economy in using large proportions of scrap, the iron was degasified, and hence showed less of the trouble commonly attributed to shrinkage. The necessary ferro-alloys were added in the form of briquettes made up with a Portland cement binder in high scrap, or high steel or wrought iron mixtures. The author prophesied that during the next few years a remarkable change would take place in foundry production, especially with the quality of the iron produced, and that it would be accompanied by changes in engineering practice. The paper was well illustrated by lantern slides.

BARROW-IN-FURNESS.

Hematite.

The condition of the hematite pig iron trade remains the same, and there is no likelihood of there being any appreciable improvement until the air is cleared as regards the coal industry. Makers are practically clearing their output, that which is not sold going to the steel departments of the two companies engaged in rolling rails, &c. Forward orders are held for deliveries into April, but beyond that month there is a certain hesitancy at present. The principal customers are in the Midlands and Scotland, although there is a certain quantity going into Wales. It is known that engineers' requirements are increasing, but there is no sign of a bigger demand at the moment. Continental trade is small, but business with America continues.

Iron Ore.

The iron ore trade remains about the same, with a moderate amount of tonnage going out of the district. Local mines are bringing up ore in restricted quantities, according to local requirements. The business in foreign ore is not on a large scale by any means, but it is steady and cargoes are arriving at intervals at Barrow and elsewhere.

Steel.

The steel trade is fair and orders are held by Barrow to keep the rail mills going for a period, but fresh contracts will be needed shortly to keep the mills going for a further period. At Workington the rail mills are still working three weeks each month, but there may be continuous running if fresh orders are secured. There are a few orders in the market. The rails which are being turned out for the North-Eastern Railway are said to be for the Peterborough district.

Hydro-electric Scheme.

After many postponements and many long discussions on the question of terms to be offered to the two companies which already obtain power from the Backbarrow Falls, the Barrow Corporation has at last decided to adopt the scheme, particulars of which were given in this letter some months ago. The scheme as originally evolved will be gone on with, but there has been a reduction in the terms offered. It is estimated that at the outset power from these falls will cost 0.44d., but when the original outlay of £90,000 has been repaid, there will be a reduction to 0.156d. There was a suggestion at the council meeting [this week that the scheme should be dropped and that the Electricity Committee should approach Vickers Ltd., who possess large power houses, to see what terms could be arrived at with them as regards a supply. This is not the first time that the proposal to take a supply from Vickers has been brought up. A year or two ago there was a motion that negotiations should be opened with Messrs. Vickers for the acquisition of the modern power station which was built during the war.

NORTH OF ENGLAND.

(From our own Correspondent.)

Iron and Steel Trade Revival.

THE turn of the tide of depression in the Northern iron and steel trade seems definitely to have been reached, and there is now a new spirit of confidence abroad. For two years or more buyers have been pursuing a policy of hand-to mouth purchases, afraid to cover more than their most pressing needs, and prepared to haggle over the smallest transaction. It was a policy for which there was ample justification, for prices had been steadily falling, and continued to do so during the whole of last year. Before the end of 1925 there were signs of improvement, but since the turn of the year there has been a remarkable accession of strength to the market. Far from checking the demand, the beginning of the upward movement in prices actually brought in more buyers, and the inference is that many consumers must have been holding their orders until the last possible moment. Some no doubt must have been caught, as there has been a sharp rise, and sales have been so heavy that there is now a definite scarcity of all kinds of iron. But the most significant change is the fact that consumers are now eager to fix forward contracts, which indicates confidence in the future. No doubt, if the risk of a miners' strike at the expiry of the coal subvention period could be eliminated, more blast-furnaces would be started, for there is still plenty of idle plant in this area; but ironmasters do not care to take the risk.

Iron and Steel Exports.

In spite of the extra charge of 6d. per ton on export orders to cover the cost of loading, the pig iron exports from the Cleveland district for January show only a small decline as compared with December, and they are, in fact, more than the monthly average for 1925. True, there has been less iron sent to the Continent, but that is very largely owing to the fact that makers have been unable to make up all the cargoes required, and the exports have been swollen by a total shipment of 7500 tons of pig iron to the United States, this reflecting the big business with American buyers reported in the closing months of 1925. The total foreign shipment of 18,678 tons of pig iron from Cleveland in January compares with 22,285 tons in December, but the coastwise shipments have advanced from 14,911 tons to 17,341 tons, so that the December aggregate, coastwise and foreign, of 37,196 tons is 1177 tons more than the January figure. Manufactured iron and steel exports for the month totalled 56,611 tons, a figure which last year was only exceeded in March and October. The steel shipments to India were the heaviest recorded since the imposition of the tariff in June, 1924, and trade with South America was also on a heavier scale than in any month last year. India received 17,355 tons, Argentine 6095 tons, Australia 4022 tons, Egypt 4151 tons, and Natal 3023 tons. The aggregate shipments of pig iron, manufactured iron and steel from the Cleveland district in January totalled 92,630 tons, a figure only exceeded twice—in March and October—last year.

Cleveland Iron Trade.

The outstanding features of the Cleveland pig iron trade continue to be a general scarcity of supplies and the strength of the market. Almost the whole of the output for February has been sold, and it is now only possible to buy small lots for delivery before March. As previously indicated, ironmasters are not prepared to put more furnaces into operation until a settlement with the coal miners has been reached. They are all well sold forward, and if for sound reasons they refrain from imposing further advances they have no difficulty in realising current quoted prices. There is still a modest export demand, but home consumers are taking the bulk of the iron, and inquiries continue on a satisfactory scale. Home prices, which are subject to a premium of 6d. per ton for export orders, are as follows:—No. 1 Cleveland foundry iron, 72s. 6d.; No. 3 G.M.B., 70s.; No. 4 foundry, 69s.; and No. 4 forge, 68s. 6d.

Hematite Pig Iron.

Active conditions also prevail in the East Coast hematite pig iron trade. Supplies are even scarcer than in foundry iron, and little can be bought for earlier than March delivery. Prices are steady and firm, 77s. 6d. per ton being a minimum figure for mixed numbers, and 78s. for No. 1.

Ironmaking Materials.

There is still an absence of business in the foreign ore trade, but the abstention of buyers from the market has in no way weakened the position of sellers, who, faced with a strong freight market, adhere to a quotation of 21s. 6d. per ton c.i.f. Tees for best Rubio ore. Easier conditions prevail in the coke market, and good Durham blast-furnace coke is selling at 21s. 6d. per ton delivered at the works.

Manufactured Iron and Steel.

A more hopeful view is taken of the outlook in the manufactured iron and steel trade. A few more orders are reported for rails and constructional material, and some of the works are fairly well employed. There are reputed to be more inquiries circulating amongst shipbuilders for new tonnage, and this should result in a fillip to the steel trade. Prices are unchanged.

The Coal Trade.

There is a brisker tone in all sections of the Northern coal trade, and this has had the effect of firming up some grades which were showing an easier tendency at the close of last week. The difficulties in respect of tonnage have now been overcome to some extent, and loading at the berths is proceeding more steadily. There are good stem sheets for the current month. Northumberland steam coals all round are steadier, under a fair amount

of demand. Best Blyth steams remain firm at 17s., and the second-hand position has improved, and the price is better at 16s. 9d. Other steam qualities also are inclined to stiffen at 16s. 6d. for Tyne primes, and 15s. 6d. to 16s. for secondary grades. Steam smalls are moving steadily, with prices well maintained at 9s. 3d. to 9s. 6d. for bests, 8s. 6d. to 8s. 9d. for seconds, and 10s. 6d. for specials. There is a sustained pressure of demand centred in every description of Durham coals, and the limited offering of supplies, owing to full bookings tends to heighten the firmness of prices. Gas coals are especially strong, though unchanged in value, and 17s. 6d. to 18s. is quoted for bests, 19s. to 19s. 6d. for special Wear kinds, and 16s. 6d. for secondary qualities. In the coke market gas makes are heavily committed over this month, and in these circumstances the full tide of the present demand cannot be dealt with, unless for more forward positions. Quotations are therefore very strong, but otherwise unaltered at 24s. 6d. to 25s. 6d. Patent foundry brands remain quiet at 21s. 6d. to 22s. 6d., and beehive cokes at 30s. to 32s., but sellers quote steadily.

Iron and Steel Imports.

Statistics presented at this week's meeting of the Tees Conservancy Commission showed that the imports of iron and steel to the Tees from European countries, India and coastwise for the three months ending January totalled 56,690 tons, as compared with 38,962 tons in the same period of 1924–25, and 17,119 tons in 1913–14. The imports of crude sheet bars, billets, blooms, slabs, &c., for the three months ended January reached 38,983 tons, as against 31,542 tons in the corresponding period of 1924–25, and 11,200 tons in 1913–14. The pig iron imported totalled 14,003 tons, as compared with 3684 tons in 1924–25, and 50 tons in 1913–14, while 3704 tons of plates, bars, angles, rails, sheets and joists were imported, as against 3736 tons in 1924–25, and 5869 tons in 1913–14.

SCOTLAND.

(From our own Correspondent.)

Clyde Shipbuilding.

DURING the month of January twelve vessels of 16,922 tons aggregate were launched from Clyde yards. Of these, only two were over 4000 tons measurement—Imperial Monarch, 5660 tons, and the Oakbank, 5200 tons. Both vessels were for Glasgow owners.

Shipbuilding Outlook.

The position in the Clyde shipbuilding industry has improved considerably during the past few days in view of a number of contracts placed, and good prospects of others to come. Messrs. Yarrow are to build four river gunboats to the order of the Admiralty, while the Blythswood Shipbuilding Company has a contract for four twin-screw motor ships of 10,000 each on behalf of Furness, Withy and Co., London. Both shipbuilding companies have their yards at Scotstoun. The machinery for the motor ships will be constructed in Greenock. Further reports include one of an order placed with Harland and Wolff for five single-screw 2500-ton motor ships, to be built at their Govan and Glasgow works. In addition to the above, which have just been published, are the following orders announced during January:—Two steamers of 8500 tons, to be built at Greenock; a cargo steamer of 4000 tons, to be built at Old Kilpatrick; and various other smaller craft. The outlook therefore may be said to have improved considerably, and in all probability local steel and ironworks will eventually feel the benefit.

Steel and Iron.

While the actual flow of business is comparatively small at present, iron and steel makers have not lost hope that the expected improvement in trade will materialise in the near future. The demand for steel plates is a shade better, but makers are handicapped by competition from English and continental producers. Steel sections show no change. Prices are inclined to firm a trifle. Makers of black and galvanised sheets report numerous inquiries for light gauges, and they anticipate busy times ahead. Meanwhile, the works are active and outputs well booked ahead. Quotations are very firm. The bar iron works have little progress to report, unless in the re-rolled steel department. The latter, though busier than the iron department, is not too well placed, and orders are generally only to be gained when keen prices are granted. The home demand for pig iron is a trifle better, and the market has a steadier appearance. Export is slower to show any change for the better, but conditions are a shade better than at the end of December.

Coal.

The export branch of the coal trade continues to show considerable activity. The market for screened coal has hardened, owing to exporters covering sales over a period, and also, it is said, to speculative buying in anticipation of extensive foreign demands. Lanarkshire splints are particularly well booked. Best Fifeshire steams are also being extensively booked, and, as is the case with splints, supplies are not available until after the end of this month. Quotations are firm. Washed materials, and especially treble nuts, are comparatively well placed. Aggregate shipments amounted to 272,760 tons, against 251,966 tons in the preceding week and 225,009 tons in the same week last year. The home market is fairly active, though industrial demands are still well below normal.

WALES AND ADJOINING COUNTIES.

(From our own Correspondent.)

Coal Trade Conditions.

THERE was a slight falling off in coal exports for the week ending January 29th, the total being just over 512,000 tons, as against 546,000 tons odd for the previous week. This decline, however, was due more particularly to tonnage being delayed owing to the bad weather. The week finished up with rather more than a dozen loading berths vacant, and unfortunately the arrivals of steamers over the week end were not on such a scale as to justify the belief that shipments this week would show any marked improvement on those of last. In the circumstances the surprise is, and has been, that the steam coal market has maintained such a good tone. The weak spots for prompt shipment have been very few, and the opinion is pretty generally held that the near future will see stronger conditions than those which have prevailed, inasmuch as a substantial amount of tonnage has been taken up for loading this month, and the majority of collieries are so well placed so far as sales are concerned, that they are refraining from selling ahead. It is certainly the case that bookings for the whole of February are very good, and market values should rule firm provided tonnage comes along as expected. Outward rates of freight also continue to be firm for practically all directions on account of the poor homeward business available. Few exporters would care to discount either present coal prices or freignt rates with the result that very much less is heard of comparatively cheap offers on a c.i.f. basis being made to buyers abroad. There is a fair inquiry for coals from Italy and from other quarters, apart from more active shipments being effected to coaling depôts abroad, but it remains to be seen whether the foreign buyer will be prepared to pay the enhanced price warranted by the prevailing high freights plus the increased value of steam coals. A certain amount of business is reported to have been done in best Admiralty large at about 23s. 6d. to 24s. for delivery over the next three months or so, but some of the collieries are asking for higher figures for supplies over this period.

Miners' Wages.

The audit for the month of December last shows that the general wage rate for which South Wales coalowners will be liable this month will be minus 0·89 per cent. of the standard rates of 1915, compared with a minus of 2·27 per cent. in January, and 7·22 per cent. in December. The payment of the minimum wage resulted in a deficiency of £810,950 for the month of December. The miners' wages for the current month show no variation, as they are guaranteed a minimum percentage of 42·24 on the 1915 standard. The output in October was 3,569,361 tons; November, 3,600,178 tons; and December, 4,007,950 tons, the last figure being the highest since January last year, when the output exceeded 4,000,000 tons. The number of man shifts worked went up from 4,328,893 in October to 4,737,720 in December, and at the same time the output per man shift worked also advanced from 16·42 cwt. to 16·92 cwt. in December.

Development Work.

The report of the Executive Committee of the Newport Development Association for last year shows that nine direct inquiries in respect of sites for new works had been dealt with. No decision had yet been arrived at regarding inquiries for 30 to 50 acres for sites for steel works, steel wire rope works, a motor-tire factory and rolling mills. A site for a mortar mill and the manufacture of concrete posts had been taken up. Among other things, the Committee had caused the removal of the anomaly of ocean freights from Newport being 3s. per ton more than from other United Kingdom ports, but the railway companies had declined to grant any further concessions to Newport, and a joint committee had been formed to deal with the matter. With regard to the Great Western Railway Company great extensions are shortly to take place at its repair depôt at Caerphilly, near Cardiff, which will necessitate the employment of an additional 2000 workmen. The directors of the Great Western Company have authorised the provision of pneumatic machinery for the opening and closing of the road bridge at the West Dock inner lock at Cardiff, and four new electric cranes, two with a lifting capacity of 6 tons and the others for 2 tons or 3 tons for general cargo at the South Quay, Newport.

Steel Trade.

At the annual meeting of the South Wales Siemens Steel Trades Conciliation Board, held last week, Sir J. C. Davies was re-elected chairman of the employers' side with Mr. Lewis Jones as secretary; whilst the Right Hon. John Hodge was re-elected chairman of the men's section with Mr. Morgan Rees as secretary.

French Railway Contracts.

The Paris and Orleans Railway has placed contracts with about six Welsh coal-exporting firms for 150,000 tons of Welsh coal for shipment from February to August. This business is of special interest in view of the fact that the same railway suspended early last year the purchase of coals from this district.

Current Business.

There has not been a great deal of fresh business passing on the steam coal market during the past week, but the tone is very steady in most departments. Dry qualities are rather lacking in demand, but otherwise collieries are very well booked up for several weeks to come. Provided tonnage comes to hand as expected many of the leading undertakings will have very little coal to offer this month. Best Admiralty large coals are firm at 23s. 6d. to 24s., and in one or two instances salesmen are not prepared to entertain forward business unless they can obtain an improvement upon existing figures. Small coals fully hold their own especially the superior qualities. Most of the collieries are working pretty regularly, and it is interesting to note that the Beynon Colliery, Blaina, belonging to the Ebbw Vale Company and employing 1500 men, worked every day during January, whereas this pit had worked only on an average of three days per week for the past three years. The anthracite trade displays very little alteration. Shipments continue on an active scale, and the demand from America is still moderately good. Although conferences continue, no news has yet come to hand of a settlement of the American anthracite miners' strike.

Catalogues.

DRUMMOND BROS, Ltd., Rhide-hill, Guildford.—Revised lists of the 3½in., 5in. and 7in. lathes.

G. H. HADLEY, Norwich Union Chambers, Congreve-street, Birmingham.—Folder describing the "Seva" electric soldering iron.

G. A. HARVEY AND CO. (LONDON), Ltd., Woolwich-road, S.E. 7.—Brochure entitled "A Catalogue of Perforated Metal Work."

BRITISH INSULATED CABLES, Ltd., Prescot, Lancs.—Leaflet P. 194, describing the "Prescot" alternating-current prepayment meter.

SWAN, HUNTER AND WIGHAM RICHARDSON, Ltd., Wallsend-on-Tyne.—Booklet describing some fruit-carrying ships built by the company.

LEISTIKOW, ALLISON AND LYON, 18, Southampton-buildings, Chancery-lane, W.C. 2.—Illustrated catalogue dealing with the "Borsig" steam valve.

CROMPTON AND CO., Ltd., Chelmsford.—List A. 6, dealing with the latest developments of three-phase induction motors for 25 and 60-cycle circuits.

DAVID BROWN AND SONS (HUDDERSFIELD), Ltd., Park Works, Lockwood, Huddersfield.—Treatise on worm gearing for automobile rear axle driving.

THE VACUUM OIL COMPANY, Ltd., Caxton House, S.W. 1.—No. 22 of the Gargoyle Technical Series, dealing with the lubrication of Uniflow steam engines.

THE GOODYEAR TYRE AND RUBBER COMPANY (GREAT BRITAIN), Ltd., Chelsea Wharf, Lots-road, S.W. 10.—Handbook of Goodyear transmission belting.

RUSTON AND HORNSBY, Ltd., Lincoln.—Booklet entitled "Modern Excavating," illustrating a variety of undertakings in which "Ruston" excavators are being used.

LONDON, MIDLAND AND SCOTTISH RAILWAY, Euston Station, London.—Booklet giving details of a new L.M.S. plan to build warehouses in important towns and particulars of those already in existence.

PERMAN AND CO., Ltd., 82–83, Fenchurch-street, E.C. 3.—Publication No. 154, illustrating and describing the British Kromhout marine oil engine and some of the vessels in which it has been fitted.

BELL'S UNITED ASBESTOS COMPANY, Ltd., 59½, Southwark-street, S.E. 1.—Illustrated booklet showing a large number of jobs carried out with Bell's Poilite and Everite asbestos cement building materials.

AUTOMATIC AND ELECTRIC FURNACES, Ltd., 173–175, Farringdon-road, E.C. 1.—Catalogue illustrating and describing the Wild-Barfield electromagnetic steel hardening furnace, together with a list of users.

THE BUTLER MACHINE TOOL COMPANY, Ltd., Victoria Ironworks, Halifax.—Sheet No. 2B, dealing with the "Butler" toolroom shaper and Sheet No. 3–3a, dealing with "Butler" high-production slotters.

THE MIRRLEES WATSON COMPANY, Ltd, Scotland-street, Glasgow.—Pamphlet No. 8515, "Mirrlees Pure Feed Water Evaporators;" No. 8520, "Mirrlees Pure Feed Water Distiller for Sugar Factories."

DAVEY, PAXMAN AND CO., Ltd., Colchester.—Catalogue No. 723, describing Paxman-Lentz steam engines; Catalogue No. 836, describing Paxman portable engines; and Catalogue No. 84, describing Naco-Pax asphalt drying and mixing plant.

THE BRITISH THOMSON-HOUSTON COMPANY, Ltd., Rugby.—Publication A.G. 188, dealing with Fabroil "A" gears; Price List 5130, of field discharge resistances; and descriptive List 4591-A of instrument transformers for line voltages up to 11,000 volts.

PERSONAL AND BUSINESS ANNOUNCEMENTS.

WE are asked to state that E. P. Allam and Co., Ltd., 107-109, Gray's Inn-road, W.C. 1, have been appointed sole agents for London and the South of England for Wright's Motors, Ltd., of Halifax.

GIBBONS BROS., Ltd., of Dibdale Works, Dudley, Worc., ask us to announce that they have acquired the business of Harvey-Siemens Furnaces, Ltd., carried on at 26, Victoria-street, Westminster, London, S.W. 1, together with the goodwill, patents, &c., of that undertaking. The business will, for the present, be conducted from the same address, and Messrs. Gibbons are retaining the services of Mr. Alfred Harvey and Mr. H. W. Jackson, who have been associated with it as directors.

WE are informed by Siemens Brothers and Co., Ltd., of Caxton House, Westminster, London, S.W. 1, and the General Electric Company, Ltd., of Magnet House, Kingsway, London, W.C. 2, that they have formed a limited liability company under the name of the Siemens and General Electric Railway Signal Company, Ltd., with registered office at 21, Great Queen-street, Kingsway, W.C. 2, to take over as from February 1st, 1926, the departments of the two companies engaged in the design and supply of railway signalling installations and apparatus.

CONTRACTS.

DRAKES LIMITED, of Halifax, has received a contract for a horizontal carbonising plant of the approximate value of £30,000 for the Huddersfield gasworks. The plant, when completed, will consist of nine beds of ten retorts, with coal-handling plant, Drakes' patented charging and discharging machine, coke-handling and screening plant.

THE MONOMETER MANUFACTURING COMPANY (1918), Ltd., of Savoy House, 115–116, Strand, London, W.C. 2, has lately received orders (*a*) for its 3-ton cable furnaces for melting lead from four important firms, two in this country and two in France; (*b*) its die casting furnaces, or its aluminium furnaces, heating ovens or melting furnaces from some ten concerns, all in this country; and (*c*) for several printers' melting furnaces for Germany and France.

IRON AND STEEL INSTITUTE.—The annual general meeting of the Iron and Steel Institute will take place on Thursday and Friday, May 6th and 7th, at the House of the Institution of Civil Engineers, Great George-street, London, S.W. 1. The annual dinner will be held on the evening of Thursday, May 6th, at the Connaught Rooms, Great Queen-street, W.C. 2.

ROYAL INSTITUTION.—A general meeting of the members of the Royal Institution was held on Monday afternoon, February 1st, Dr. Ernest Clarke, a Manager, in the chair. The special thanks of the members were returned for an anonymous donation of £500 to the research fund. Mr. H. J. Heckle, Dr. G. K. C. Kaye, Mrs. Shaw Stewart, Mr. R. M. Weston, and Mr. H. J. Yates were elected members.

Current Prices for Metals and Fuels.

IRON ORE.

N.W. Coast—	
Native	21/-
(1) Spanish	18/6
(1)N. African	18/6
N.E. Coast—	
Native	—
Foreign (c.i.f.)	21/6

PIG IRON.

	Home. £ s. d.	Export. £ s. d.
(2) Scotland—		
Hematite	3 17 6	—
No. 1 Foundry	3 19 0 to 4 1 6	
No. 3 Foundry	3 16 6 to 3 19 0	
N.E. Coast—		
Hematite Mixed Nos.	3 17 6	3 17 6
No. 1	3 18 0	3 18 0
Cleveland—		
No. 1	3 12 6	3 13 0
Silicious Iron	3 12 6	3 13 0
No. 3 G.M.B.	3 10 0	3 10 6
No. 4 Foundry	3 9 0	3 9 6
No. 4 Forge	3 8 6	3 9 0
Mottled	3 7 6	3 8 0
White	3 7 6	3 8 0
Midlands—		
(3) Staffs.—		
All-mine (Cold Blast)	10 10 0	—
North Staffs. Forge	3 17 6	—
,, ,, Foundry	4 7 6	—
(3) Northampton—		
Foundry No. 3	3 5 0	—
,, Forge	2 16 0 to 2 17 0	
(3) Derbyshire—		
No. 3 Foundry	3 7 6	—
Forge	3 3 0	—
(3) Lincolnshire—		
No. 3 Foundry	3 8 0	—
No. 4 Forge	3 5 0	—
Basic	3 6 0	—
(4) N.W. Coast—		
N. Lancs. and Cum.—		
Hematite Mixed Nos.	4 10 0 (a) / 4 12 0 (b) / 4 17 0 (c)	—

MANUFACTURED IRON.

	Home. £ s. d.	Export. £ s. d.
Scotland—		
Crown Bars	11 5 0	—
Best	—	—
N.E. Coast—		
Common Bars	11 0 0	—
Lancs.—		
Crown Bars	11 10 0	—
Second Quality Bars	11 0 0	—
Hoops	15 0 0	14 15 0
S. Yorks.—		
Crown Bars	12 10 0	—
Best ,,	13 10 0	—
Hoops	14 10 0	—
Midlands—		
Crown Bars	11 10 0 to 12 0 0	
Marked Bars (Staffs.)	14 0 0	—
Nut and Bolt Bars	10 10 0 to 11 0 0	
Gas Tube Strip	12 10 0	—

STEEL.

	(6) Home. £ s. d.	(7) Export. £ s. d.
(5) Scotland—		
Boiler Plates	11 0 0	—
Ship Plates, ¾in. and up.	7 10 0 to 7 12 6	
Sections	7 0 0 to 7 2 6	
Steel Sheets, under 3/16in. to ¼in.	9 0 0 to 9 2 6	
Sheets (Gal. Cor. 24 B.G.)	—	£17 to £18

STEEL (*continued*).

	Home. £ s. d.	Export. £ s. d.
N.E. Coast—		
Ship Plates	7 7 6	—
Angles	7 0 0	—
Boiler Plates	11 10 0	—
Joists	7 0 0	—
Heavy Rails	8 0 0	—
Fish-plates	12 0 0	—
Channels	10 5 0	£9 to £9 5
Hard Billets	8 2 6	—
Soft Billets	7 5 0	—
N.W. Coast—		
Barrow—		
Heavy Rails	8 0 0†..	—
Light ,,	8 5 0 to 8 10 0	
Billets	7 10 0 to 9 0 0†	
Manchester—		
Bars (Round)	8 5 0 to 8 10 0	
,, (others)	8 0 0 to 8 5 0	
Hoops (Best)	15 5 0	15 0 0
,, (Soft Steel)	13 15 0	13 10 0
Plates	7 17 6 to 8 5 0	
,, (Lancs. Boiler)	11 10 0	—
Sheffield—		
Siemens Acid Billets	10 10 0	—
Bessemer Billets	11 5 0	—
Hard Basic	8 12 6	—
Intermediate Basic	8 2 6	—
Soft Basic	7 5 0	—
Hoops	12 0 0	—
Soft Wire Rods	9 10 0	—
Midlands—		
Small Rolled Bars	7 17 6 to 8 0 0	
Billets and Sheet Bars	6 2 0 to 6 10 0	
Sheets (20 W.G.)	11 10 0 to 12 0 0	
Galv. Sheets, f.o.b. L'pool	16 7 6 to 16 12 6	
Angles	7 0 0 to 7 5 0	
Joists	7 0 0 to 7 5 0	
Toes	8 0 0 to 8 5 0	
Bridge and Tank Plates	7 15 0 to 8 0 0	
Boiler Plates	11 0 0 to 12 0 0	

NON-FERROUS METALS.

Swansea—	
Tin-plates, I.C., 20 by 14	19/4½ to 19/9
Block Tin (cash)	279 5 0
,, (three months)	274 7 6
Copper (cash)	58 12 6
,, (three months)	59 15 0
Spanish Lead (cash)	34 6 3
,, (three months)	34 0 0
Spelter (cash)	37 2 6
,, (three months)	36 13 9
Manchester—	
Copper, Best Selected Ingots	65 10 0
,, Electrolytic	66 10 0
,, Strong Sheets	90 0 0
,, Tubes (Basis Price)	0 1 1
Brass Tubes (Basis Price)	0 1 0
,, Condenser	0 1 2½
Lead, English	37 0 0
,, Foreign	36 0 0

FERRO ALLOYS.

(*All prices now nominal.*)

	Per Ton.	Per Unit.
Tungsten Metal Powder	2/1 per lb.	
Ferro Tungsten	1/11 per lb.	
Ferro Chrome, 4 p.c. to 6 p.c. carbon	£23 10 0	8/-
,, 6 p.c. to 8 p.c. ,,	£23 0 0	7/6
,, 8 p.c. to 10 p.c. ,,	£22 7 6	7/-
,, Specially Refined		
,, Max. 2 p.c. carbon	£40 10 0	14/-
,, ,, 1 p.c. ,,	£47 0 0	16/-
,, ,, 0·70 p.c. carbon	£56 10 0	17/6
,, ,, carbon free	1/5 per lb.	
Metallic Chromium	3/6 per lb.	
Ferro Manganese (per ton)	£15 for home, £15 for export	
,, Silicon, 45 p.c. to 50 p.c.	£12 2 6 scale 5/- per unit	
,, ,, 75 p.c.	£21 15 0 scale 6/- per unit	
,, Vanadium	15/- per lb.	
,, Molybdenum	6/- per lb	
,, Titanium (carbon free)	1/- per lb.	
Nickel (per ton)	£172 to £175	
Cobalt	10/- per lb.	
Aluminium (per ton)	£120	

FUELS.

SCOTLAND.

	Export.
Lanarkshire—	
(f.o.b. Glasgow)—Steam	17/3
,, ,, Ell	18/-
,, ,, Splint	21/- to 23/6
,, ,, Trebles	18/-
,, ,, Doubles	16/6
,, ,, Singles	14/3
Ayrshire—	
(f.o.b. Ports)—Steam	17/6
,, ,, Jewel	18/6
,, ,, Trebles	18/-
Fifeshire—	
(f.o.b. Methil or Burntisland)—Steam	14/3 to 17/-
Screened Navigation	21/6
Trebles	18/6 to 19/6
Doubles	16/6
Singles	14/6
Lothians—	
(f.o.b. Leith)—Best Steam	16/-
Secondary Steam	15/6
Trebles	17/6
Doubles	16/9
Singles	14/3

ENGLAND.

	Inland.
(8) N.W. Coast—	
Steams	24/6
Household	40/- to 45/-
Coke	27/-
Northumberland—	
Best Steams	17/-
Second Steams	16/-
Steam Smalls	9/9 to 10/-
Undscreened	14/-
Household	20/- to 22/-
Durham—	
Best Gas	17/-
Second	16/3 to 16/6
Household	20/- to 22/-
Foundry Coke	22/- to 24/-
Sheffield—	
Best Hand-picked Branch	31/- to 34/-
Barnsley Best Silkstone	28/- to 30/- —
Derbyshire Best Brights	26/- to 28/- —
,, ,, House	24/- to 25/- —
,, ,, Large Nuts	17/- to 20/- —
,, ,, Small	12/6 to 14/- —
Yorkshire Hards	17/- to 19/6 —
Derbyshire ,,	16/- to 19/- —
Rough Slacks	10/- to 12/6 —
Nutty ,,	7/6 to 9/- —
Smalls	3/6 to 6/- —
Blast-furnace Coke (Inland)*	— —
,, ,, (Export)	f.o.b. 19/3 to 19/9

(9) SOUTH WALES.

Cardiff— Steam Coals :	
Best Smokeless Large	23/- to 24/-
Second ,,	21/6 to 22/6
Best Dry Large	21/- to 22/-
Ordinary Dry Large	20/6 to 21/-
Best Black Vein Large	21/- to 21/6
Western Valley Large	20/- to 20/6
Best Eastern Valley Large	20/- to 20/6
Ordinary ,, ,,	19/- to 20/-
Best Steam Smalls	13/6 to 14/-
Ordinary ,,	11/- to 13/-
Washed Nuts	19/- to 30/-
No. 3 Rhondda Large	27/- to 27/6
,, ,, Smalls	17/- to 18/-
No. 2 ,, Large	19/- to 20/-
,, ,, Through	16/6 to 17/6
,, ,, Smalls	10/6 to 11/-
Foundry Coke (export)	37/6 to 40/-
Furnace Coke (export)	25/- to 30/-
Patent Fuel	20/- to 22/6
Pitwood (ex ship)	23/9 to 24/3
Swansea— Anthracite Coals :	
Best Big Vein Large	41/6 to 42/6
Seconds	35/- to 37/6
Red Vein	28/- to 31/-
Machine-made Cobbles	52/6 to 55/-
Nuts	55/- to 57/6
Beans	42/6 to 45/-
Peas	21/- to 24/-
Breaker Duff	8/- to 8/6
Rubbly Culm	9/- to 9/6
Steam Coals :	
Large	22/- to 23/6
Seconds	20/- to 22/-
Smalls	9/- to 10/-
Cargo Through	16/6 to 18/-

(1) Delivered. (2) Net Makers' works. (3) f.o.t. Makers' works, approximate. (4) Delivered Sheffield. (5) Glasgow, Lanarkshire, and Ayrshire.

(6) Home Prices—All delivered Glasgow Station. Boiler Plates 10/- extra delivered England. (7) Export Prices—f.o.b. Glasgow. (8) Except where otherwise indicated, coals are per ton at pit for inland and f.o.b. for export, and coke is per ton on rail at ovens and f.o.b. for export. (9) Per ton f.o.b. * For blast-furnaces only, 17/-, with fluctuations according to analysis; open market, 17/6 to 19/- at ovens. † Latest quotations available. (a) Delivered Glasgow. (b) Delivered Sheffield. (c) Delivered Birmingham.

French Engineering Notes.

(From our Correspondent in Paris.)

Industrial Burdens.

THE effect of the new taxation proposals is likely to be to change completely the industrial situation, which, it is feared, by increasing manufacturing costs, will restrict buying on the home market and deprive makers of the advantages they possess as regards export trade. If, at the same time, the increased revenue accruing from the taxation should cause an appreciable improvement in the franc the situation may become serious. After the recent speculative buying, which has provided iron and steel makers with work for three or four months ahead, business has come practically to a standstill, and in the engineering industries new contracts are very scarce. One of the chief grievances at the moment is the way in which burdens are being laid upon the manufacturing industries, and as the tax on payments is not likely to be accepted, the Minister of Finance proposes to levy a tax on production; that is to say, it will be borne solely by manufacturers and wholesale dealers, representing one quarter of the number of taxpayers under the former scheme. If the same estimated revenue is to be obtained the tax must be at least 5 per cent., and it will probably be made sufficiently elastic to provide additional revenue if required. The result will necessarily be to augment the cost of products out of all proportion to the tax.

Higher Import Duties.

The delay in presenting the new Tariff Bill is already regarded as seriously prejudicing the manufacturing industries, and there is no indication yet of anything being done to hasten the introduction into the Chamber of Deputies of a measure which aims at putting the import duties on a gold basis and adjusting them in such a manner as will offer protection to home industries. Meanwhile the Government is finding it necessary to raise money from every possible source, and on the plea that the existing duties are no longer effective in view of the depreciation of the franc it is now considering the advisability of raising the import duties by 30 per cent. That is obviously a financial expedient, for the manufacturing industries have no need of further protection when it is adequately provided by the money depreciation; but what they do require is cheaper raw material which has to be purchased abroad, and the proposed higher tariffs will therefore compel them to pay more and, by increasing manufacturing costs, will place them in a far less satisfactory position for doing business abroad.

Suburban Traffic.

The huge increase in the population of Paris, which has had to spread over vast suburban areas that not long ago were regarded as purely rural resorts, has raised a problem in transport which is causing tribulation to suburban dwellers and much loss to the railway companies. The trouble lies in the low charges for season tickets, while the amount paid for workmen's weekly tickets is so small that many thousands of passengers are being carried daily at infinitesimal individual fares. All suburban traffic, therefore, entails a serious loss. It is true that the rates have been raised, but that only provoked a storm of indignation from suburban dwellers, and it is obviously difficult at the present moment to increase them sufficiently to make the service pay. The railway companies are, of course, unable to improve a service on which any expenditure represents a dead loss. The Minister of Public Works has been trying to find a way out of the difficulty by suggesting that as the city of Paris benefits from the suburban traffic it should make up for any deficit in the working of the railways. The Municipal Council is protesting in a way that can leave the Minister with no illusion as to the ultimate fate of any such proposal. He has therefore decided to lay the matter before a commission which will be required to investigate the possibility of making over the whole of the suburban railway system to a company which would control the traffic in the departments of the Seine, Seine and Oise and Seine and Marne.

The Naval Air Force.

Of the credits already voted for the naval air force a considerable proportion remains unspent, because it has been found impossible so far to settle upon a definite policy of air strategy and seaplane construction. In 1923 a sum of 103 million francs was voted, and the budget now under discussion provides for a further expenditure of 108 million francs. Nothing has yet been done to show how the money can be usefully spent. So far there have been conflicting ideas as to what shall constitute a naval air force. The impression that the flying machine and the submarine have vanquished the battleship has long taken hold of the public mind, and the illusion can only be dispelled by adducing proofs of its fallacy. All naval experts are now agreed that squadrons of aircraft cannot supplant battleships, but that they are absolutely necessary to the operations of a fleet. Nevertheless, nothing has been done to co-ordinate ideas and produce a definite plan, with the result that while Britain and the United States are building seaplanes and flying boats for definite uses the French are still employing many types of amphibious machines which could not remain on the water for any length of time. To begin with, therefore, the Minister of Marine has presented a project of organisation known as the Statute of Naval Aviation, which covers in detail the whole service and provides for the creation of fifty squadrons, each squadron constituting a tactical unit. The trouble so far is that the French aviation service has never been able to settle upon a definite line of policy. It has always aimed at improvements and achieving something better, and it has continued along more or less experimental lines, while other countries have been developing into practical machines types of aircraft that are quite good enough for the purpose. The research work carried out in France is of a very high order, and there is obviously always the possibility of new and interesting developments, but the French are now of the opinion that it is unsafe to allow the aviation service to carry out experiments indefinitely.

British Patent Specifications.

When an invention is communicated from abroad the name and address of the communicator are printed in italics.

When an abridgment is not illustrated the Specification is without drawings.

Copies of Specifications may be obtained at the Patent Office, Sale Branch, 25, Southampton-buildings, Chancery-lane, W.C., at 1s. each.

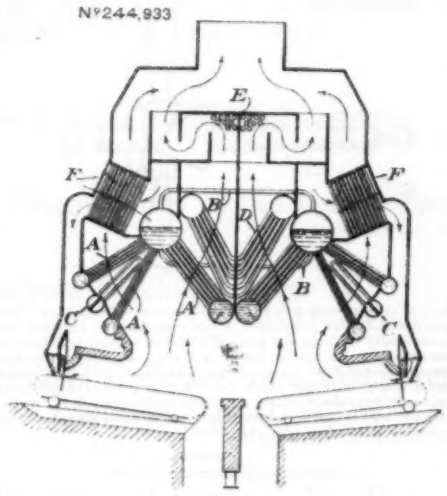
The date first given is the date of application; the second date, at the end of the abridgment, is the date of the acceptance of the complete Specification.

STEAM GENERATORS.

244,933. January 20th, 1925.—WATER-TUBE BOILERS, P. W. Robson, Dunelm House, Church-lane, Lincoln.

This steam generator is, broadly speaking, a double-ended water-tube boiler of the Yarrow type with a common furnace fired at both ends. Within the one casing there are also air pre-

N°244,933

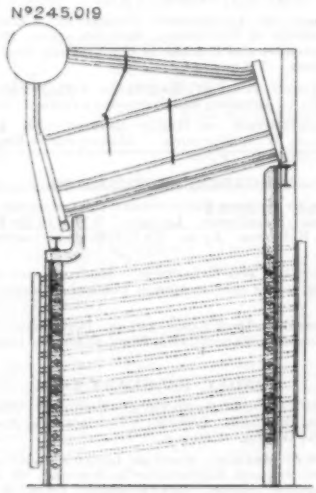


heaters, superheaters, re-heaters and feed-water heaters. The steam generating tubes are shown at A A A and the two steam drums are connected together by the balancing pipes B B. The superheaters are at C C and the re-heater at D. The feed-water heater or economiser is indicated at E, and F F are the air pre-heaters.—*December 31st*, 1925.

245,019. July 3rd, 1925.—BOILER FURNACES, Babcock and Wilcox, Ltd., Babcock House, Farringdon-street, London, E.C. 4, and A. Speyer.

In accordance with this invention the tubes of the cage or skeleton framework of a water-cooled fire-box, which are arranged at a slight inclination to the horizontal, are connected

N°245,019



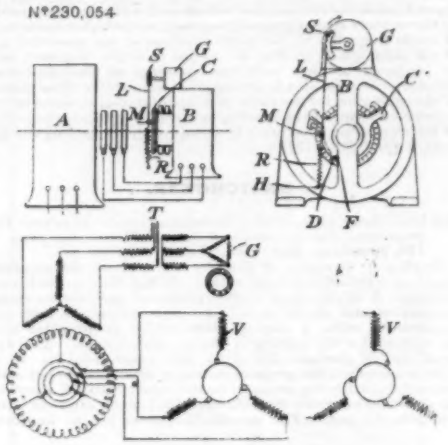
at their ends to vertically disposed headers arranged externally of the furnace and not as heretofore on the furnace lining. This vertical disposition of the headers externally of the furnace facilitates connection of the tubes of the framework or cage to the headers and allows of convenient repair.—*December 31st*, 1925.

DYNAMOS AND MOTORS.

230,054. February 20th, 1925.—APPARATUS FOR IMPROVING THE POWER FACTOR OF INDUCTION MOTOR COMBINATIONS, *The British Thomson-Houston Company, Ltd., of Crown House, Aldwych, W.C. 2.*

In the application of induction motors to rolling mills the motor has been compounded to increase its slip as a function of the load so as to allow the utilisation of a part of the kinetic energy of a fly-wheel to smooth out the peaks of the current taken from the mains. The arrangement most frequently employed for this purpose comprises the progressive introduction of resistance in the secondary of the induction motor by means of a slip regulator, which serves to increase the value of the resistance when the load increases. With this arrangement, however, the power factor cannot be improved. It is also known that the slip of the induction motor can be increased and the power factor improved at the same time by introducing a commutator motor with series characteristic into the secondary circuit of the induction motor, but with that arrangement compounding is not generally as efficient as with the above-mentioned apparatus, as the slip is large at normal load and the saturation of the commutator machine tends to diminish the compounding coefficient when the load increases. This method also does not allow the power factor to be improved at very light or zero load. The object of the present invention is to obtain a very accentuated compound characteristic and at the same time the power factor can be improved at no load and full load. In the upper illustration A is an induction motor and B a commutator machine mounted on the same shaft. G is a slip regulator. A spring R tends to maintain the brush system of the machine B in the position corresponding to the generating position, whilst the regulator G tends to draw the brushes in the opposite direction, through the medium of the connection L. The regulator G is constituted by a squirrel-cage motor having on its shaft a

N°230,054

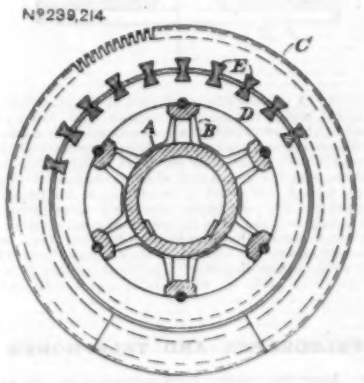


sector S, on which the cord L winds and is connected at M to the brush carrier. The spring R is connected between M and a point H on the frame of the machine, and an abutment D on the brush carrier bears at F on the frame to limit the extreme position of the brushes. The lower diagram shows the electrical connections of the system with the brushes in the position corresponding to the operation of the commutator machine as a generator. The right-hand lower diagram shows the brushes in the position for motor operation. The induction motor is provided with a primary winding and a secondary winding, which supplies current to the primary V of the commutator machine. The slip regulator G is provided with current from the secondary of a transformer T, the primary of which is traversed by the primary current of the induction motor.—*December 31st*, 1925.

239,214. August 26th, 1925.—IMPROVEMENTS IN OR RELATING TO ROTORS FOR ELECTRICAL MACHINES, Siemens-Schuckert-werke Gesellschaft mit beschrankter Haftung, of Berlin-Siemensstadt, Germany.

The rotor described in this specification is for high-speed electrical machines. A is the hub of the rotor. The parts B

N°239,214

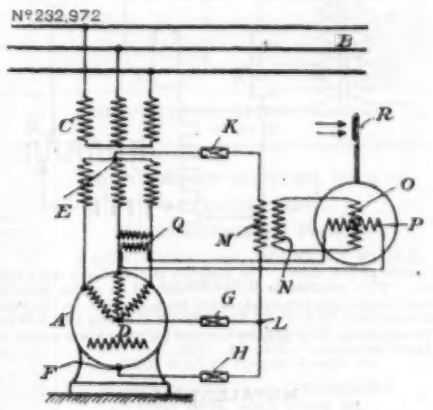


and C are sheet metal segments and are connected to the hub. Between both parts there is an intermediate carrier ring D composed of material of high tensile strength which carries the sheet metal segments C. These are connected to the carrier ring by wedge-shaped intermediate pieces or keys E. Instead of the segments shown undivided plates may obviously be used.—*December 24th*, 1925.

232,972. April 23rd, 1925.—PROTECTIVE ARRANGEMENTS FOR ALTERNATING-CURRENT GENERATORS, Siemens-Schuckert-werke Gesellschaft mit beschränkter Haftung, of Berlin-Siemensstadt, Germany.

This invention relates to an improvement in the protective

N°232,972



connections of alternating-current generators associated with power transformers, in which the zero point of the generator, the zero point of the lower voltage side of the transformer and the earthed casing of the generator are connected to a junction

point, whilst between this junction and one of the two zero points there is a relay which causes the switching off of the generator and places a warning signal in circuit when a short circuit occurs in the windings of the generator or between a winding and the earthed casing. The three-phase generator A feeds the circuit B through a transformer C. The zero or neutral point D of the generator winding, the primary zero point E of the transformer, and a contact point F on the generator casing are connected through the resistances G, H and K to one and the same branching or junction point L. Between this branching point and the zero point of the transformer there is a transformer M, the secondary coil N of which feeds the current coil O of the watt meter type relay. The tension coil P of the relay is connected, with the interposition of a transformer Q, between two generator windings. The contact pointer R of the relay closes the circuit which operates the safety device. The relay is dependent on the current and voltage and will only be operated by the currents of fundamental frequency, as the higher harmonics of treble frequency in the three windings of the generator are of the same phase, so that no voltage of treble frequency will be produced between each two windings of the generator. Voltage coils could also be arranged between all the three phases of the generator, for the purpose of maintaining, in the event of a short-circuiting of the winding between two phases, the action of the watt meter type relay by means of the remaining voltage coils.—*April 23rd*, 1925.

SWITCHGEAR.

238,194. June 17th, 1925.—IMPROVEMENTS IN ELECTRIC OIL SWITCHES, *The International General Electric Company, of 120, Broadway, New York, U.S.A.*

Explosion chambers or pots for oil switches are generally made of a cylindrical tube with a closing plate at each end. Although it is easy to give the cylindrical part the necessary mechanical and electrical stability, it is difficult to fulfil this requirement with a closing plate which is provided with an opening for the ingoing of the movable contact. This end must be so mechanically fixed and constructed as to be able to withstand the pressure arising in the explosion pot without metal parts being arranged on the outside surface, otherwise an arc might be struck from the movable contact after the latter has left the pot. The specification describes an improved

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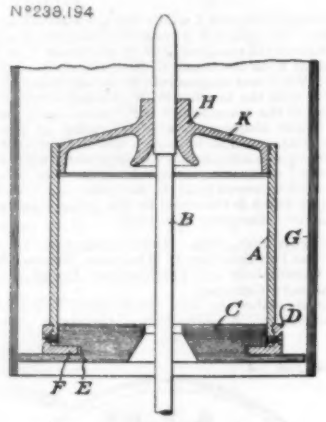

arrangement. A is the cylindrical part of the chamber, preferably of metal, and B the movable contact. The lower end C of the chamber through which the contact passes is made of one piece of insulating material with sufficient mechanical strength. It is provided with an annular slot E in which the flange F of the fastening ring D engages and which is clamped firmly to the cylindrical part A. In order to be able to fit the flange of this ring into the slot E it may be cut into two or more pieces. After the base C has been placed in the required position with respect to the cylinder A the individual parts of the ring D can be placed over it and clamped. An additional insulating cylinder G can be placed over the entire chamber. The fixed contact H is formed in the other end plate K, which is of metal.—*December 31st*, 1925.

TELEGRAPHS AND TELEPHONES.

233,718. May 7th, 1925.—IMPROVEMENTS IN OR RELATING TO THERMIONIC VALVE SYSTEMS, *The Edison Swan Electric Company, Ltd., of 123–125, Queen Victoria-street.*

This specification describes a thermionic valve system in which a common source of electrical supply supplies the cathode

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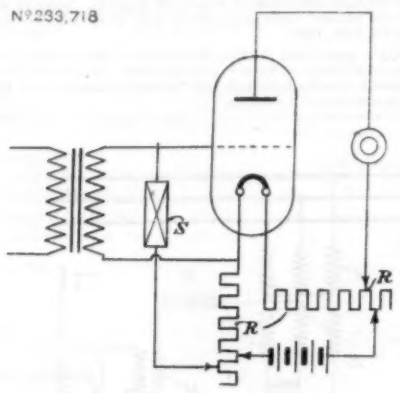

and anode of the valve. The diagram is practically self-explanatory. Two resistances R are connected in series with the cathode circuit and the anode is fed from a point on the right-hand resistance, and it will be gathered that the two voltages can be adjusted. S is a grid leak connected at its lower end to the left-hand resistance.—*May 7th*, 1925.

METALLURGY.

244,523. September 18th, 1924.—PROCESSES FOR COATING FERROUS METALS TO MAKE THEM RUST-PROOF, C. F. Hendrick, 10, Berwick-street, Victoria, London, S.W. 1.

This invention relates to a process which has for its object the prevention of rust on the surfaces of all ferrous metal goods. In carrying out the process the surface of the ferrous metal is subjected to such heat from, for instance, an oxy-acetylene blow-pipe as will, to the required depth, bring the metal to melting point and simultaneously therewith the non-ferrous metal, with or without the employment of a flux, is applied to the molten ferrous metal surface with which it becomes fused and unites to form a homogeneous junction, the quantity of non-ferrous metal so applied being sufficient to complete a continuous and integral coating of the desired thickness over the ferrous metal. The non ferrous metal may be initially in a divided, ribbon, or other suitable form, which on contact with the source of heat is readily raised to melting point, and may be projected or otherwise applied under pressure to the surface of the ferrous metal.—*December 18th*, 1925.

MISCELLANEOUS.

244,981. April 28th, 1925.—IMPROVEMENTS IN OR RELATING TO ELECTRIC INSULATORS, George Victor Dowding and Keith Dudley Rodgers, both of Fleetway House, Farringdon-street, E.C. 4.

It is found in practice that ordinary insulators gradually deteriorate in resistance owing to the deposit of dirt and soot on the surface, and they also suffer temporary reduction in resistance from deposits of moisture such as rain and dew. The

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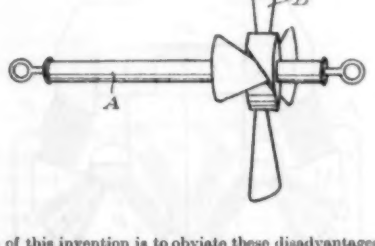

object of this invention is to obviate these disadvantages. The improved insulator comprises a body portion and means for automatically rubbing the surface to remove dust, moisture or other deposits. On the insulator A a rotor B is mounted, and when it is acted upon by the wind it revolves and also moves longitudinally, with the result that the hub portion of the rotor continually rubs the insulator and keeps it clean and dry. Apparently the idea is mainly applicable to insulators associated with wireless aerials.—*December 31st*, 1925.

Forthcoming Engagements.

Secretaries of Institutions, Societies, &c., desirous of having notices of meetings inserted in this column, are requested to note that, in order to make sure of its insertion, the necessary information should reach this office on, or before, the morning of the Wednesday of the week preceding the meetings. In all cases the TIME *and* PLACE *at which the meeting is to be held should be clearly stated.*

TO-DAY.

CHEMICAL ENGINEERING GROUP: MANCHESTER SECTION.—Textile Institute, 16, St. Mary's Parsonage, Manchester. Paper, "Fluid Heat Transmission for High Temperatures in Industrial Processes," by Mr. J. A. Reavell. 7 p.m.

INSTITUTION OF LOCOMOTIVE ENGINEERS: MANCHESTER CENTRE.—College of Technology, Sackville-street, Manchester. Paper, "Principles and Practice in the Erecting Shop," by Mr. P. H. Saunders. 7 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Question and discussion evening. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "Shakespeare's English," by Professor G. Gordon. 9 p.m.

SATURDAY, FEBRUARY 6TH.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH.—Grand Hotel, Manchester. Lecture, "A Day in the Foundry," by Mr. J. G. Robinson. 4 p.m. To be followed by annual dinner at 6.30 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Students' visit to Lloyd's new building, under construction in Leadenhall-street, London, E.C. 3.

STAFFORDSHIRE IRON AND STEEL INSTITUTE.—Visit to Chemical Research Laboratories, Council House, Birmingham. 3 p.m.

MONDAY, FEBRUARY 8TH.

BRADFORD ENGINEERING SOCIETY.—Technical College, Great Horton-road, Bradford. Lecture, "Refrigerating Machinery," by Mr. G. W. Wilson. 7.30 p.m.

INSTITUTE OF METALS: SCOTTISH LOCAL SECTION.—Institution of Engineers and Shipbuilders in Scotland, 39, Elmbank-crescent, Glasgow. Paper, "Wire Weaving," by Mr. J. Gilchrist. 7.30 p.m.

INSTITUTION OF AUTOMOBILE ENGINEERS: BIRMINGHAM CENTRE.—Chamber of Commerce, New-street, Birmingham. Paper, "Modern Chassis Frame Design and Body Mounting," by Mr. T. D. Carpenter. 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS: GRADUATES' SECTION.—Storey's-gate, Westminster, London, S.W. 1. Paper, "Submerged Combustion and Submerged Flame Burners," by Mr. E. C. Peters. 7 p.m.

SURVEYORS' INSTITUTION.—12, Great George-street, London, S.W. 1. Paper, "The Rating and Valuation Act, 1925," by Mr. F. M. Konstam. 8 p.m.

TUESDAY, FEBRUARY 9TH.

ELECTRICAL ASSOCIATION FOR WOMEN.—E.L.M.A. Lighting Service Bureau, 15, Savoy-street, London, W.C. 2. Lecture, "The Public Service of Electricity and the Housewife," by Mr. J. W. Beauchamp. 7 p.m.

INSTITUTE OF BRITISH FOUNDRYMEN: LANCASHIRE BRANCH, BURNLEY SECTION.—Municipal College, Ormerod-road, Burnley. Paper, "A Talk on Foundry Work," by Mr. H. Shackleton. 7.15 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, London, S.W. 1. Paper, "Construction of the New Entrance to Tranmere Dock," by Mr. P. W. Bertlin. 6 p.m.

INSTITUTION OF ELECTRICAL ENGINEERS: SCOTTISH CENTRE.—Royal Technical College, Glasgow. Paper, "An All-electric House," by Dr. S. Parker Smith. 7.30 p.m.

INSTITUTION OF PETROLEUM TECHNOLOGISTS.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "The Sulphur Compounds of Kimmeridge Shale Oil," by Dr. F. Challenger, Messrs. J. Haslam, R. J. Bramhall, and J. Walkden. 5.30 p.m.

MANCHESTER GEOLOGICAL AND MINING SOCIETY.—Queen's Chambers, John Dalton-street, Manchester. Paper, "Steam Winding Engines," by Mr. H. Pilling. 4 p.m.

WEDNESDAY, FEBRUARY 10TH.

ASSOCIATION OF ENGINEERING AND SHIPBUILDING DRAUGHTSMEN: BIRMINGHAM AREA TECHNICAL COMMITTEE.—Chamber of Commerce, New-street, Birmingham. Lecture, "Extra High-tension Switchgear," by Mr. G. L. E. Metz. 7.30 p.m.

ELECTROPLATERS' AND DEPOSITORS' TECHNICAL SOCIETY.—Northampton Polytechnic Institute, St. John-street, Clerkenwell, London, E.C. 1. Paper, "A General Survey of Chromium Plating," by Mr. E. A. Ollard. 8.15 p.m.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, London, S.W. 1. Informal meeting. Discussion on "British Railway Permanent Way Working," introduced by Mr. W. A. Willox. 6 p.m.

INSTITUTION OF ENGINEERS-IN-CHARGE.—St. Bride Institute, Bride-lane, Fleet-street, London, E.C. 4. Paper, "The Testing and Continuous Control of Steam Boiler Plant," by Mr. D. Brownlie. 7.30 p.m.

THURSDAY, FEBRUARY 11TH.

INSTITUTE OF METALS: LONDON LOCAL SECTION.—Institute of Marine Engineers, 85-88, The Minories, London, E. 1. Paper, "The Fatigue of Metals: A General Survey and an Account of some Recent Work, Part II.," by Mr. H. J. Gough and Dr. D. Hanson. 7.30 p.m.

FRIDAY, FEBRUARY 12TH.

BOROUGH POLYTECHNIC INSTITUTE.—Borough-road, London, S.E. 1. Annual prize distribution. 7.30 p.m.

DEPARTMENT OF CHEMICAL ENGINEERING.—University College, Gower-street, London, W.C. 1. Public lecture, "The Theory of Fine Grinding," by Dr. Geoffrey Martin. 5 p.m.

INSTITUTE OF METALS: SHEFFIELD LOCAL SECTION.—Applied Science Department of the University, St. George's-square, Sheffield. Paper, "Drop Forgings," by Dr. O. F. Hudson. 7.30 p.m.

INSTITUTION OF ENGINEERING INSPECTION.—Royal Society of Arts, John-street, Adelphi, London, W.C. 2. Paper, "The Application of Special Cast Irons in the Engineering Industry," by Mr. S. E. Dawson. 7.30 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, London, S.W. 1. Informal meeting. Discussion on "Refrigerating Machinery," introduced by Mr. G. C. Hodson. 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS: YORKSHIRE BRANCH.—Hotel Metropole, Leeds. Paper, "The Choice of Steels for Engineering Work," by Mr. A. P. Hague. 7.30 p.m.

JUNIOR INSTITUTION OF ENGINEERS.—39, Victoria-street, London, S.W. 1. Honorary members' lecture, "A Visit to some Power Stations in the U.S.A. in 1925," by Mr. W. H. Patchell. 7.30 p.m.

ROYAL INSTITUTION OF GREAT BRITAIN.—21, Albemarle-street, London, W. 1. Discourse, "The Chemistry of Blue and Red Colouring Matters of Flowers," by Professor R. Robinson. 9 p.m.

WOMEN'S ENGINEERING SOCIETY.—26, George-street, Hanover-square, London, W. 1. Lecture, "Some Problems of the Machinery Market," by Miss E. M. Kennedy. 6.30 p.m.

MONDAY, FEBRUARY 15TH.

ELECTRICAL ASSOCIATION FOR WOMEN.—E.L.M.A. Lighting Service Bureau, 15, Savoy-street, London, W.C. 2. Lecture, "Electric Light in the Home," by Mr. W. E. Bush and Miss Hodge. 7 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. Cantor Lecture, "The Production and Measurement of High Vacua, I.," by Dr. G. W. C. Kaye. 8 p.m.

TUESDAY, FEBRUARY 16TH.

STAFFORDSHIRE IRON AND STEEL INSTITUTE.—Girls' High School, Dudley. Discussion on "Wrought Iron *v.* Steel." 7 p.m.

WEDNESDAY, FEBRUARY 17TH.

INSTITUTION OF CIVIL ENGINEERS.—Great George-street, London, S.W. 1. Students' meeting. Paper, "Sub-aqueous Tunnelling in Compressed Air, with reference to Barking Power Station Cable Tunnel under the River Thames," by Mr. D. S. Matheson. 6 p.m.

ROYAL SOCIETY OF ARTS.—John-street, Adelphi, London, W.C. 2. "The Propagation of Electric Waves," by Mr. J. E. Taylor. 8 p.m.

THURSDAY, FEBRUARY 18TH.

INSTITUTION OF STRUCTURAL ENGINEERS: YORKSHIRE BRANCH.—Great Northern Hotel, Leeds. Paper, "Transverse Bracing of Bridges," by Professor J. Husband. 6.30 p.m.

FRIDAY, FEBRUARY 19TH.

INSTITUTION OF LOCOMOTIVE ENGINEERS.—The Engineers Club, Coventry-street, London, W. 1. Annual dinner. 6.30 for 7 p.m.

INSTITUTION OF MECHANICAL ENGINEERS.—Storey's-gate, Westminster, London, S.W. 1. Annual general meeting. Paper, "The Measurement of Cutting Temperatures," by Mr. E. G. Herbert. 6 p.m.

INSTITUTION OF MUNICIPAL AND COUNTY ENGINEERS.—The Council House, Birmingham. West Midland District meeting. Paper, "Concrete in Modern Road Construction," by Mr. H. V. Overfield. 5.30 p.m.

RAILWAY CLUB.—65, Belgrave-road, London, S.W. 1. Annual general meeting, followed by presidential address. 7.30 p.m.

SATURDAY, FEBRUARY 20TH.

STAFFORDSHIRE IRON AND STEEL INSTITUTE.—Dudley Arms Hotel, Dudley. Annual dinner. 6 p.m.

MONDAY, FEBRUARY 22ND.

INSTITUTION OF STRUCTURAL ENGINEERS: MIDLAND COUNTIES BRANCH.—Chamber of Commerce, Birmingham. Paper, "Arterial Road Construction," by Mr. H. F. Lea. 7.30 p.m.

RAILWAY CLUB.—65, Belgrave-road, London, S.W. 1. Paper, "Development of the Railway Carriage," by Mr. B. M. Bazley. 8.15 p.m.

TUESDAY, FEBRUARY 23RD.

INSTITUTE OF MARINE ENGINEERS.—85–88, The Minories, Tower Hill, London, E. 1. "The Principles and Practice of Automatic Steering," by Mr. F. S. Clifford. 6.30 p.m.